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EFFECTS OF SUBSTITUTION OF FERMENTED CHICKEN LITTER WITH CONCENTRATE ON NUTRIENT DIGESTIBILITY AND PERFORMANCE OF SHEEP

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ABSTRACT: The study aimed to investigate the effects of supplementing fermented chicken litter on feed consumption, nutrient digestibility (dry matter/DM, organic matter/OM, crude fiber/CF, extract ether/EE, crude protein/CP), total digestible nutrients (TDN), and average daily gain (ADG) in sheep. A completely randomized design with 4 treatments and 3 replications, namely T0 = concentrate without the addition of fermented litter, T1 = 90% concentrate + 10% fermented litter, T2 = 80% concentrate + 20% fermented litter, T3 = 70% concentrate + 30% fermented litter and T4 = 60% concentrate + 40% fermented litter was used. The parameters studied were dry matter digestibility (DMD), organic matter digestibility (OMD), extract ether digestibility (EED), crude fiber digestibility (CFD), crude protein digestibility (CPD), TDN, feed consumption and average daily gain. The results revealed that sheep fed different levels of fermented litter did not affect OMD, DMD, EED, CPD, CFD, TDN, dry matter consumption, and average daily gain (ADG). It was concluded that fermented chicken litter can be incorporated in sheep diet, without considerable negative effects.

Keywords: Digestibility, Feed, Fermentation, Litter, Sheep.

INTRODUCTION

Poultry farming in Indonesia is the largest livestock production sector with the fastest population growth. Statistics Indonesia (BPS) recorded that the broiler population in 2018 - 2020 in Indonesia reached 3 trillion heads (Statistics Indonesia, 2020). Poultry litter is a material used as a base for cages and has several functions such as absorbing excreta, ammonia, and heat insulation (Munir et al., 2019; Pepper and Dunlop, 2021). The development of broiler cages that are getting wider has increased the amount of litter/manure waste that has the potential to pollute the environment and disrupt human health (Wang et al., 2019). Statistics Indonesia (2020) noted that the increase in broiler chicken production in Indonesia caused waste in the form of litter and manure by 15.72%, so handling and processing efforts were needed.

Litter has a crude protein content of 25 – 50% and TDN of 55 – 60% (Rahimi et al., 2018). Litter contains nitrogen proteins such as uric acid, purines, and allantoin which serve as the basic ingredients for the synthesis of rumen microbes (Van Ryssen, 2001), with acid detergent fiber (ADF) content (26.17 ± 0.40%), neutral detergent fiber (NDF) (40.11 ± 0.54%), lignin (6.91 ± 0.37%), CuO (1.15%), MgO (42.53%) and Al_2O_3 (10.19%) which can be degraded by microorganisms during the fermentation process (Utama and Christiyanto, 2021).The litter must go through a processing process so that it can be used optimally and not harmful to livestock (Utama and Christiyanto, 2021).

Fermentation is a process of microorganism activity in obtaining the energy needed for metabolic processes through the breakdown of organic compounds both aerobically and anaerobically and resulting in changes in the substrate (Owens and Basalan, 2016). The activity of these microorganisms is expected to reduce crude fiber levels and improve the quality of feed ingredients (Supriyati et al., 2014).

This study aimed to examine the feeding of fermented litter as a substitute for sheep concentrates on dry matter digestibility (DMD), organic matter digestibility (OMD), crude protein digestibility (CPD), crude fiber digestibility (CFD), total digestible nutrients (TDN), dry matter consumption and average daily gain.

MATERIALS AND METHODS

The material used in the study was 15 female local sheep with a weight of ±11 kg. The research design used was a completely randomized design (CRD) with 4 treatments and 3 replications, namely TO = concentrate without the addition

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of fermented litter, T1 = 90% concentrate + 10% fermented litter, T2 = 80% concentrate + 20% fermented litter, T3 = 70% concentrate + 30% fermented litter and T4 = 60% concentrate + 40% fermented litter.

Litter was fermented using starter *exceed* for 6 weeks then the fermented product was ground until smooth. Sheep were adapted to treatment for 14 days and then followed by data collection for 10 days. Maintenance was carried out for 4 weeks with feeding 2 times in one day. The feed is provided in the form of forage and concentrate. Stool collection was carried out 1 × 24 hours for 10 days, then continued with proximate analysis and calculated digestibility. The concentrate consists of rice bran, corn, Corn Gluten Feed (CGF), palm cake, soybean groats, molasses, minerals, salt, and fermented litter. The composition of the treatment ration can be seen in Table 1.

Table 1 - Composition feed of the treatment.

Feed ingredients \ Treatments	T0	T1	T2	T3	T4
Bran	40	28	19	17	18
Corn	8	14	14	14	10
Palm kernel meal	20	17	17	17	11
Soybean groats	8	7	6	6	7
Corn gluten meal	20	20	20	12	10
Salt	1	1	1	1	1
Molasses	2	2	2	2	2
Mineral	1	1	1	1	
Litter fermentation	0	10	20	30	40

T0 = concentrate without the addition of fermented litter, T1 = 90% concentrate + 10% fermented litter, T2 = 80% concentrate + 20% fermented litter, T3 = 70% concentrate + 30% fermented litter and T4 = 60% concentrate + 40% fermented litter

Parameter estimate

The parameters observed in this study were dry matter consumption, dry matter digestibility (DMD), organic matter digestibility (OMD), extract ether digestibility (EED), crude fiber digestibility (CFD), crude protein digestibility (CPD), Total Digestible Nutrients (TDN), and average daily gain (ADG). The measurement of DMD, OMD, EED, CFD, CPD, and TDN is calculated using the formula of Alsersy et al. (2014):

$$\text{DMD}= \frac{\text{DM Consumption - DM Excreted}}{\text{DM Consumption}} \times 100\%$$

$$\text{OMD}= \frac{\text{OM Consumption - OM Excreted}}{\text{OM Consumption}} \times 100\%$$

$$\text{CFD}= \frac{\text{CF Consumption - CF Excreted}}{\text{CF Consumption}} \times 100\%$$

$$\text{EED}= \frac{\text{EE Consumption - EE Excreted}}{\text{EE Consumption}} \times 100\%$$

$$\text{CPD}= \frac{\text{CP Consumption - CP Excreted}}{\text{CP Consumption}} \times 100\%$$

TDN = % digestible crude fiber + % digestible NFE + % digestible crude protein + 2,25 % digestible extract ether

Measurement of average daily gain and feed consumption was calculated using the formula of Abebe and Tamir (2016):

$$\text{Average daily gain (ADG)}= \frac{\text{Final Weight (kg)-Initial Weight (kg)}}{\text{"Maintenance Length (days)"}}$$

$$\text{Dry matter consumption (Kg DM/head/day)}= \frac{\text{"Total Feed given (kg DM) - Total Remaining Feed (kg DM)"}}{\text{"Maintenance Length (days)"}}$$

Data analysis

Research data were analyzed using analysis of variance (ANOVA). When the results of the analysis showed a real effect, it was continued with Duncan's difference test at the 5% level.

Animal ethical regulation

The treatment of experimental animals was carried out in accordance with the "Guidelines for the Care and Utilization of Laboratory Animals" from Diponegoro University. All procedures carried out in this study involving animals have been following ethical standards and approved by the Feed Technology Laboratory of the Faculty of Animal Husbandry and Agriculture, University Diponegoro.

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RESULTS AND DISCUSSIONS

Nutrient digestibility data, DM consumption, daily body weight gain sheep

Based on the research results in Table 2 showed that there was no significant effect (P>0.05) of different feed treatments on nutrient digestibility, DM consumption and daily body weight gain of sheep.

Table 2 - Nutrient digestibility, and daily body weight gain in Sheep.

Parameters \ Treatments	T0	T1	T2	T3	T4	P-values (P<0.05)
Dry matter consumption (kg/head/day)	0.55	0.55	0.55	0.54	0.54	NS
DMD (%)	71.36 ± 6.37	67.64 ± 5.91	67.42 ± 7.05	69.56 ± 3.34	67.41 ± 3.47	NS
OMD (%)	73.73 ± 5.44	70.00 ± 5.72	70.00 ± 6.45	71.54 ± 3.36	69.58 ± 3.26	NS
EED (%)	57.25 ± 4.95	65.77 ± 8.88	68.24 ± 10.02	55.97 ± 5.67	70.91 ± 3.68	NS
CFD (%)	63.40 ± 6.97	49.11 ± 10.28	52.51 ± 10.15	56.26 ± 6.11	53.72 ± 9.07	NS
CPD (%)	76.99 ± 5.19	76.94 ± 5.20	75.30 ± 5.19	75.61 ± 2.85	73.21 ± 1.58	NS
TDN (%)	65.55 ± 4.85	66.23 ± 6.98	62.86 ± 5.89	60.80 ± 2.90	59.00 ± 2.76	NS
Average daily gain (kg/head/day)	0.19 ± 0.04	0.21 ± 0.07	0.20 ± 0.04	0.22 ± 0.02	0.20 ± 0.03	NS

NS: non-significant (P>0.05); Dry matter digestibility (DMD), organic matter digestibility (OMD), extract ether digestibility (EED), crude fiber digestibility (CFD), crude protein digestibility (CPD), and Total Digestible Nutrients (TDN). T0 = concentrate without the addition of fermented litter, T1 = 90% concentrate + 10% fermented litter, T2 = 80% concentrate + 20% fermented litter, T3 = 70% concentrate + 30% fermented litter and T4 = 60% concentrate + 40% fermented litter

Dry matter consumption

Based on Table 2, it can be seen that the average DM consumption of local sheep feed is 0.54 – 0.55 kg/head/day. This value is by the standard by Gerlach et al. (2015) that the consumption of DM feed that has high quality can reach 3.5% of body weight. The nutritional quality of the feed given will affect livestock productivity. McGrath et al. (2018) stated that feed consumption in ruminants was influenced by several factors such as palatability, energy requirements, feed form, physiological status, and production. Scherer et al. (2015) stated that the ability to consume DM shows an effort to fulfil the body's nutritional needs for development.

Dry matter digestibility (DMD)

Results showed that the administration of fermented litter in treatments T0, T1, T2, T3, and T4 did not affect the DMD value of sheep. The highest DMD value of 80.97% with T0 treatment could occur because the nutrient content in the ration was easily digested by rumen microbes. This value is higher than the results of research by Al-Galbi (2013) which states that the provision of broiler excreta in feed provides a DMD value of 61.39 – 65.56%. The high DMD value is thought to be caused by the ability of microbes to break complex bonds such as the lignin content in the ration to be simpler. Langda et al. (2020) stated that high levels of lignin in feed caused microbes in the rumen unable to degrade nutrients in cells so that the digestibility produced was low. The high DMD value in the T3 treatment indicated that the dry matter ration was able to be digested by microbes.

Organic matter digestibility (OMD)

The results showed that the increase in fermented litter substitution in concentrate did not affect the OMD value of sheep. The absence of this difference is presumably because the DMD values are not different. Gao et al. (2015) stated that ration OMD can be an indicator that OM ration is easy to be degraded by rumen microbes and digested by post-rumen digestive enzymes. The highest OMD value was 82.13% in the T0 treatment, while the lowest OMD value was 79.01% in the T2 treatment. This value is higher than the results of the study by Shahowna et al. (2013) that the value of OMD litter added to the ratio ranged from 67.35 – 79.79%. Gao et al (2015) stated that the high and low of OMD are related to DMD because organic matter is part of dry matter.

Extract ether digestibility (EED)

Statistical test results showed that the concentrate substitution treatment with fermented litter gave no significant results. Extract Ether digestibility increased no-significantly with increasing fermentative litter composition. This is caused by the binding of triglyceride complexes to the feed with the addition of fermented litter. Lam et al. (2010) stated that high-fat triglyceride bonds do not break down into simple bonds such as fatty acids and alcohols so the evaporation process due to alcohol does not occur. Irungu et al. (2018) added that the main effect of the high digestibility value of EE is influenced by the chemical structure of fat which is highly digestible by livestock compared to protein. The main effect of increasing fat absorption is on the amount of triglyceride content rather than free fatty acids. Patra (2014) stated that

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the ability to digest fat increases when it is dominated by unsaturated fatty acid bonds, there are short - chain fatty bonds, and contains more triglyceride molecules compared to free fatty acids.

Crude fiber digestibility (CFD)

The digestibility of CF sheep fed different fermented litter feeds in vivo showed that the results had no effect. Litter fermentation on extract ether had no significant effect, presumably due to the influence of cellulose degradation. The crude fiber in sheep has a role in balancing the buffer by helping the process of rumen saliva production. The highest CFD value was 76.88% with T0 treatment, while the lowest CFD value was 68.79% with T1 treatment. Lignin can be a major factor in the high content of crude fiber. Islam et al. (2017) stated that CF has a relationship with digestibility, the lower the CF, the higher the digestibility of the ration. Lignin as a component of CF is a complex substance that is difficult to digest. Behan et al. (2019) stated that the digestibility of CF is influenced by high and low cell wall fractions. Hemicellulose and cellulose are cell wall components that can be digested by rumen microbes.

Crude protein digestibility (CPD)

Crude protein digestibility of sheep fed different fermented litter feeds in vivo showed that there was no significant effect. Crude protein digestibility value is a percentage of CP contained in the consumed ration and not found in livestock feces, CPD is influenced by CP value. The CPD value was influenced by the protein content in the ration. Tilman et al. (2005) stated that CPD depends on protein content and the amount of protein that enters the digestive tract, the higher the protein content, the higher the digestibility. The highest CPD value was 84.22% with the T1 treatment, while the lowest CPD value was 69.67% with the T0 treatment. The high CP content in the ration will cause the rate of reproduction and the number of microbes in the rumen to increase. Soltan et al (2018) stated that an increase in the number of microbes in the rumen will cause more enzymes that digest CP and an increase in CPD. The DMD value of a ratio is closely related to the CPD value. Pazla et al. (2021) stated that the CPD value is directly proportional to the DMD.

Total digestible nutrients (TDN)

The results showed that the treatment with fermented litter did not affect the TDN value of the sheep. TDN shows the amount of energy consumed by livestock. Omer et al. (2019) stated that the TDN value is an illustration of the total energy consumed by livestock from feed or rations. The TDN value is influenced by the nutritional content in the feed ration. Van Soest (1994) stated that the TDN value was obtained from the digestibility value of the fiber, protein, fat, and carbohydrate components present in the feed. Alshelmani et al. (2016) added that the TDN consumed by livestock will be high because the NFE consumed is high, a high TDN will support an increase in ration efficiency.

Average daily gain (ADG)

The substitution of concentrate with fermented litter did not statistically give any difference in the value of average daily gain. The results showed that the average value of daily gain for sheep ranged from 0.187 to 0.223 kg. This value is higher than the research of Abad et al. (2015) who reported that the average daily gain of local goats ranging from 3 to 6 months of age was 40 g. Body weight gain is thought to be influenced by the nutrient content in the ration. Madeira et al. (2017) stated that the factors affecting body weight gain were influenced by the palatability of the ration and the nutrient content in the ration such as adequate protein and energy.

CONCLUSION

Based on the results of this research, it can be concluded that giving fermented litter can be used as a substitute for sheep feed concentrate because it shows the same performance as giving without fermented litter. It was concluded that fermented chicken litter can be incorporated in sheep diet, without considerable negative effects.

DECLARATIONS

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Authors' contribution

MCH and CSU provide recommendations and suggestions on research topics, article preparation and finalization of scientific articles; EPA and LKN conduct research and analysis of productivity and performance parameters; SRN conducts article preparation and research data processing

Conflict of interests
The authors declare that they have no competing interests.

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