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Abstract. Cocoa pulp can be used as an alternative to molasses in a complete feed formulation with low-quality agricultural byproducts as the main fiber source. The purpose of this study was to determine the nutrient digestibility of complete feed containing cocoa pulp with different fiber sources for local goats. Twelve local male goats, aged 1-1.5-year-old, were placed in individual metabolism cage (1 goat/cage). Then each goat was randomly assigned to get one of three experimental diets according to a completely randomized block design consisting of three treatment diets and four blocks as replications. Initial body weight of the animal was used as the base for grouping. The experimental ration was P1= complete feed with rice straw as the fiber source, P2= complete feed with corn cobs as the fiber source, and P3= complete feed with soybean straw as the fiber source. The three types of complete feed contained 10% of cocoa pulp. The analysis of variance showed that the treatment did not give a significant effect (P>0.05) on the nutrient digestibility of complete feed. In conclusion, the three types of fiber sources, i.e., rice straw, corn cobs, and soybean straw can be used in complete feed formulation containing 10% of cocoa without deteriorating effects on nutrient digestion of complete feed for the local goat.

1. Introduction

Feed is the main factor in the livestock business. The availability of feed with sufficient quality, quantity and continuity greatly affect the success of the livestock business. Currently, the feed industry in Indonesia is highly dependent on imported feed ingredients, even though Indonesia has many potential feed sources. For example, optimally utilizing agricultural waste as a feed source to fulfill animal feed needs, but agricultural waste is a low-quality feed due to high structural carbohydrate content.

One of the agricultural wastes that can be used as feed ingredients in ruminants is cocoa pulp. The cocoa pulp is a waste from the cocoa fermentation process which is usually just thrown away. The potential of cocoa pods skin in Indonesia is quite large, both in terms of quantity and quality. The availability of cocoa pods skin in the harvest season is very large and is able to fulfill the needs for 635,305 livestock per year. Cocoa pods skin as a source of fiber can replace grass. The chemical composition of cocoa pods skin contains crude protein between 6.80-13.78%; SDN 55.30-73.90% and SDA 38.31-58.98% [1].

The cocoa pulp contains a lot of glucose which can be used as an energy source for livestock. The cocoa pulp is a white mucous membrane that wraps cocoa beans, there are about 25-30% of the weight of the seeds, and also contains sugar with relatively high levels around 10-13% [2]. During

fermentation, 15-20% of the pulp liquid waste can be produced from the weight of fermented cocoa beans [3]. The pulp liquid as a side product waste during fermentation of cocoa beans, contains acetic acid, lactic acid, and alcohol. These organic acids are formed from the fermentation of sugars contained in cocoa bean pulp.

Currently, many energy sources are used to mix ruminant feed, i. e., waste from the sugar industry in the form of molasses. However, the availability of molasses has decreased because it competes with the needs of other sectors. Therefore, the cocoa pulp is another alternative that can be chosen to fulfill ruminant feed needs. Its utilization as feed ingredients, cocoa pulp needs to be improved in quality, among others by adding to complete feed.

The use of complete feed is indeed very relevant to simplify the fulfillment of very high nutritional needs (especially energy), and at the same time is able to substantiate the fiber needs (NDF) which is very important for the stabilization of the rumen ecosystem. In addition, complete feed also guarantees better distribution of daily intake of rations, so that fluctuations in ecosystem conditions within the rumen are minimized [4].

This condition is more difficult to achieve by conventional feeding where fiber source feed (roughage) and concentrate feed are given separately.

According to the results of a study from [5], cocoa pulp can be used up to a level of 10% in complete feed. Utilization of up to 10% cocoa pulp in complete rations does not affect the in vitro digestibility of dry matter and in vitro digestibility of organic matter. The high digestibility of dry matter in ruminants shows a high digestibility of nutrients, especially those digested by rumen microbes. This indicates that the use of cocoa pulp in complete feed up to 10% does not negatively affect the use of nutrients by goat livestock. The purpose of this research is to determine the digestibility of nutrition of complete feed containing cocoa pulp with different fiber sources in goat livestock.

2. Materials and methods

This research was conducted from March to May 2018. This research was conducted based on Randomized Block Design (RBD) consisting of 3 treatments and 4 groups [6]. Each treatment lasts for 17 days consisting of 12 days of habituation period and 5 days of the sampling period. Complete feed treatment is distinguished by the source of fiber used. The four treatments are P1: Complete feed containing 50% rice straw, P2: Complete feed containing 50% corn cobs and P3: Complete feed containing 50% soybean straw. Fiber sources are rice straw, soybean straw, corn cobs and other feed ingredients milled using a hammer mill to simplify the mixing process. Then each feed ingredient is weighed according to the proportion in the ration and mixed evenly.

Table 1. Feedstuff composition of the complete fed according to the treatment

Feedstuff (%) (DM basis)	Treatments		
	P1	P2	P3
Rice Straw	50	-	-
Corn Cobs	-	50	-
Soybean Straw	-	-	50
Rice Bran	20	20	20
Coconut cake meal	9	9	9
Cocoa pulp	10	10	10
Shrimp waste meal	6	6	6
Salt	1,5	1,5	1,5
Mineral Mix	2	2	2
Urea	1,5	1,5	1,5
Total	100	100	100

P1= complete feed with rice straw as the fiber source, P2= complete feed with corn cobs as the fiber source, and P3= complete feed with soybean straw as the fiber source.

This research used goat livestock which was placed in a metabolic cage that has been equipped with feed and drink containers. Feed is given twice a day at 08.00 and 16.00 WITA with the same proportion. Drinking water is given in *ad libitum*.

Sampling is carried out for the last 5 days of each period. Samples collected include leftovers and feces. Each leftover and feces were collected and weighed for 5 days sampling period and mixed homogeneously then sampled as much as 10% for the laboratory analysis.

2.1 Variables observed

The variables observed in this study were nutrient digestibility which included digestibility of dry matter, digestibility of organic matter, digestibility of crude protein, digestibility of crude fat, digestibility of BETN, digestibility of ADF and digestibility of NDF.

2.2. Data analysis

The average digestibility of dry matter, digestibility of organic matter, digestibility of crude protein, digestibility of crude fat, digestibility of BETN, digestibility of ADF and digestibility of NDF are processed by variance analysis according to a 3 x 4 Randomized Block Design, 3 treatments, and 4 groups. If the treatment has a significant effect, a further test is carried out using Duncan's Multiple Range Test (Sastrosupadi, 2000) with a mathematical formula of $Yijk = \mu + \tau i + \beta j + \varepsilon ij$ where, Yij = the observation of the-I change with j-test, μ = the average of observation, τi = the effect of the-i treatment (i: 1,2 and 3), βj = the effect of the j-group (j: 1,2,3 and 4) and εij = the effect of the experimental error from the i-treatment and j-test.

3. Results and discussion

3.1 Chemical components of the experimental diets

Based on laboratory analysis to determine the chemical composition of complete feed containing cocoa pulp with different fiber sources as follows:

Table 2. Chemical components of the experimental diets

Parameters	Treatments		
	P1	P2	P3
BO (%)	88,69	85,64	77,67
PK (%)	15,38	12,69	16,83
LK (%)	6,36	2,76	5,77
SK (%)	19,04	29,30	23,53
BETN (%)	47,91	40,89	31,54
ABU (%)	11,31	14,36	22,33
ADF (%)	30,27	37,96	27,98
NDF (%)	43,37	53,64	42,19
Cell (%)	23,79	22,35	18,93
Hemicell (%)	13,10	15,68	14,21
Lignin (%)	6,44	15,59	9,03
ATL (%)	0,04	0,02	0,02

[a]Animal Feed Chemical Laboratory, Hasanudin University, 2017. P1= complete feed with rice straw as the fiber source, P2= complete feed with corn cobs as the fiber source, and P3= complete feed with soybean straw as the fiber source.

The crude protein content of complete feed prepared at each treatment averaged around 14%, but the results of laboratory analysis showed protein content in P1 (15.38), P2 (12.69) and P3 (16.83). Although there were differences in the protein content of the laboratory analysis results in each treatment, all complete rations contain proteins above the minimum level of minimum requirement of crude protein, ruminants ration which is 7.5% [7].

3.2. Effect of treatment on nutrient digestibility of complete feed containing cocoa pulp with different fiber sources in goats livestock

The average effect of treatment on digestibility of dry matter, digestibility of organic matter, digestibility of crude protein, digestibility of crude fat, digestibility of BETN, digestibility of ADF and NDF are shown in table 3.

Table 3. Average digestibility of dry matter, digestibility of organic matter, digestibility of crude protein, digestibility of crude fat, digestibility of BETN, digestibility of Acid Detergen Fiber (ADF) and Neutral Detergen Fiber (NDF)

Parameters	Treatments		
	P1	P2	P3
digestibility of dry matter (%)	0,71±0,24	0,73±0,22	0,71±0,34
digestibility of organic matter (%)	0,77±0,24	0,76±0,21	0,74±0,28
digestibility crude protein (%)	0,78±0,02	0,75±0,29	0,80±0,32
digestibility crude fat (%)	0,92±0,13	0,83±0,51	0,87±0,32
digestibility BETN (%)	0,83±0,25	0,80±0,26	0,79±0,19
digestibility of ADF (%)	0,58±0,27	0,68±0,22	0,52±0,67
digestibility of NDF (%)	0,64±0,25	0,71±0,42	0,66±0,49

P1= complete feed with rice straw as the fiber source, P2= complete feed with corn cobs as the fiber source, and P3= complete feed with soybean straw as the fiber source.

Variation analysis showed the frequency of providing complete feed containing cocoa pulp with different fiber sources had no significant effect (P> 0.05) on nutrient digestibility of goat feed (digestibility of dry matter, digestibility of organic matter, digestibility of crude protein, digestibility of crude fat, digestibility of BETN, digestibility of ADF and NDF).

The table also shows that the digestibility of crude protein is not significant. Digestibility of crude protein, namely, P1 0.78%, P2 0.75% and P3 0.80%. Statistically, the digestibility of crude protein in each treatment showed no difference, meaning that all treatments given were equally influential on the digestibility of crude protein in male Kacang Goat.

One of the factors that affect the digestibility of crude protein is the protein content in rations consumed by livestock. Rations with low protein content generally have low digestibility and vice versa. High and low protein digestibility is affected by the protein content of ration ingredients and the amount of protein that enters the digestive tract [8].

The digestibility of dry matter ranges from 0.71% to 0.73% with an average range of 0.72%. The table 3 shows high digestibility but by giving cocoa pulp the dry matter content is lower because the use of cocoa pulp that is too high allows too much gas and cause low digestibility. Factors that affect the digestibility of dry matter, i.e., the amount of ration consumed, the rate of food in the digestive tract and the type of nutrient content contained in the ration. This is in accordance with the opinion of [9] which stated that feed digestibility will be determined by degradation characteristics and flow velocity (outflow rate) or the rate of feed ingredients leaving the rumen while feed consumption will be determined by feed digestibility and rumen capacity.

The results of variance showed that the treatment had no significant effect (P> 0.05) on the digestibility of ADF and NDF. The average digestibility of the ADF ranges from 0.52 (%) - 0.68 (%), the NDF digestibility value ranges from 0.64 (%) - 0.71 (%). NDF digestibility is relatively higher compared to ADF digestibility. This is because NDF has an easily digestible fraction in the rumen, namely hemicellulose, while the components found in ADF are cellulose, lignin, and silica [10] Increased NDF digestibility and ADF digestibility of complete rations with different fiber sources due

to non-disruption of the rumen microbial population, especially cellulolytic microbes. The relatively stable condition of rumen pH for rumen microbial growth especially cellulolytic microbes causes a better growth of cellulolytic bacteria, therefore, the digestibility of fiber fractions also increases. Rumen microbial activity is affected by pH, pH of normal rumen fluid in goat ranges from 6-7 [7].

Statistically, there is no difference between ADF and NDF digestibility treatment but numerically it can be seen that ADF digestibility in goats that get ration in P2 is relatively higher than ADF digestibility on treatment P1 and P3 as well as NDF digestibility. Digestion of feed ingredients is a reflection of the high and low value of the benefits of feed ingredients by measuring the amount of food consumed and the amount of food released through feces [11]. But according to [12] that the NDF content is reported to affect consumption levels through the filling effect, which should have an effect on the digestibility of ADF and NDF.

4. Conclusion

A complete feed containing 10% cocoa pulp with three sources of fiber, those are rice straw, corn cobs and soybean straw can be used in complete feed formulations without adverse effects on nutritional digestibility of complete feed for goats.

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