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Research Article

Performance, Feeding Behavior, and Nutrient Utilization of Different Goat Breeds Fed Creep Feed

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ABSTRACT

Introduction: Feed is one of the main factors to improve animal production. The utilization of feed is depended on quality, quantity, type, breed, and rate of passage of feed. This study aimed to evaluate the performance, feeding behavior, and nutrient utilization of growing Etawah crossbred and Senduro goats fed different forms of starter concentrate of creep feed.

Materials and methods: Twelve local growing goats were used in this study, consist of six Etawah crossbred and six Senduro goats with average body weight 20 ± 1.57 kg from both sex, fed different forms of creep feed for three month. This study was designed by factorial randomized completely block design 2x2. The first factor was type of creep feed form (mash and pellet), and the second factor was the type of goat breeds (Etawah crossbred and Senduro). The complete ration consisted of 70% creep feed containing black soldier fly (BSF) meal and BSF oil plus 30% elephant grass. The variables observed were feeding behavior nutrient consumption, digestibility, blood metabolites, and performance.

Results: The results showed that there was no interaction between the creep feed forms and the goat breeds in all variables. The form of creep feed had a significant effect on prehension and mastication. The pellet form had higher prehension and mastication compared to mash from but it had no significant effect on nutrient consumption and digestibility. Performance and blood metabolites were same in all treatments, except for the feed efficiency of Senduro goats had higher than Etawah crossbred goats.

Conclusion: In conclusion, giving creep feed containing BSF larvae meal and oil in starter concentrate as pellet forms resulted a lower prehension and higher mastication, but has higher prehension and lower mastication for mash type. The performance and blood metabolites were are not different in all treatment groups.

1. Introduction

Feed is the major factor to support animal production. Kinds of ingredient, quality of feed, cutting age of forage and form of feed are affect to the performance. Protein is dominant needed to express growth rate, especially in post weaning animal. Mostly protein source for ruminant is from legume, but sometimes from plan meal such soybean meal and palm kernel meal. One of the alternative protein source from animal is insect, such as black soldier fly (BSF), especially giving for functional feed. According to the statement of Astuti and Wiryawan[1] BSF meal and its oil could be used for functional diet in ruminant. BSF containing high protein (42-47%), ether extract (11.8-34.8%), crude fiber (7-9%), and ash (14.6-15.9%). Some diets containing BSF meal and oil have been formulated and produced as milk replacer for new born livestock, flushing diet for supporting reproduction and creep feed

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for fast growing ruminant. Creep feed is a high-quality concentrate diet to support fast growing of post weaning animal. Result by giving BSF meal creep feed proved that the performance of the goat or sheep better than control treatment[1]. Giving a pellet meal in the creep feed ration for growing kids gave good palatability and not affected to the rumen fermentation profiles[2]. Eating behavior is a part of the success feed which could be converted to the performance. Rumination including regurgitation, re-mastication and fermentation, are the main activities in the tractus digestive which improve to the digestibility of nutrient[3].

Indonesia has many indigenous and crossbred small ruminant breeds. Goat population in Indonesia is increase by year, where in 2022 there were more than 18.90 million head, including meat and dairy goat[4]. Dairy goat like etawah crossbred, saanen and senduro are reared for producing milk, meanwhile the male goat is for meat[5]. Etawah crossbred is produced from crossing between etawah with local kacang goat, meanwhile senduro goat is produced from crossing between etawah with local kacang goat and jawarandu goat[6]. Goats are traditionally reared in Indonesia for meat, milk and dual-purpose production. The senduro goat is dual purpose type[7]. Etawah and senduro have specific performance like long ear, white and black hair and concave face[8]. The senduro male have good potential as meat type due to they have high performance of gain.

Study regarding the BSF utilization as mash creep feed has been done to evaluate performance of etawah crossbred and kacang goat. Result showed that BSF meal could substitute 100% of soybean meal in the concentrate creep feed and improved dry matter consumption and digestibility of nutrient with ADG around 110 g/h/d[9]. It is very rare data on eating behavior of indigenous Indonesian goat, especially fed with different form of concentrate creep feed. This study was aimed to evaluate the performance, feeding behavior, nutrient absorption and blood metabolite profiles of growing senduro and etawah crossbred goats fed different form of concentrate creep feed.

2. Material and Methods

2.1. Ethical approval

Approval for the current study was given by the Animal Care and Use Committee (ACUC) at IPB University with No. 122-2023 IPB.

2.2. Study area

The study was carried out for six months in the laboratory field Department of Nutrition and Feed Technology, Faculty of Animal Science IPB University Indonesia. The proximate and blood analysis were done in the laboratory of feed technology and laboratory meat and draught animal nutrition in the same faculty.

2.3 Sample collection

Twelve local growing goats were used in this study

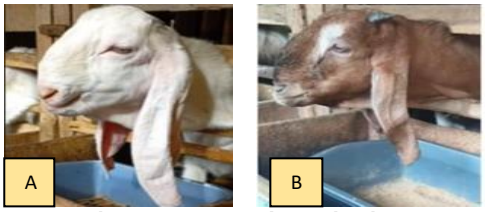

Figure 1. A: Senduro goat. B: Etawah crossbred goat.

with average Body Weight 20 ± 1.57 kg equal from both sex, consisted of six Etawah crossbred and six of Senduro goats.

The complete ration consisted of 70% concentrate creep feed containing BSF meal and BSF oil plus 30% elephant grass (*Pennisetum purpureum*) with the cutting age of 50-60 day. The creep feed is made in two form (mash and pellet) and formulated from local feedstuffs such as corn mill, pollard, soybean meal, BSF meal, BSF oil, palm kernel meal, molasses, cassava meal, CaCO3, NaCl, premix and DCP. The ration containing 16.70% of crude protein and 75% of TDN (Tabel 1).

Table 1. Nutrient composition of concentrate creep feed and elephant grass (%DM)

Nutrients	Concentrate creep feed[1)]	Elephant grass[1)]
	----------%----------	
Dry matter	92.41	24.64
Ash	7.52	8.44
Crude protein	23.14	8.93
Ether extract	7.68	2.52
Crude fiber	4.30	26.60
NFE	57.36	53.51
TDN	88.42	60.54

[1)] Lab. Analysis (2023)

The feeding treatment was done for three months with a week for adaptation period. Variables observed during three months evaluation were performance, feeding behavior, nutrient consumption, digestibility, and blood metabolites. Monitor CCTV was setting to support data collecting of feeding behavior including prehension, rumination, regurgitation, re-mastication and fermentation, according to method as mention by Nørgaard[10]. Digestibility of nutrient was measured by total collection method during a week, with three days adaptation period in the metabolic cage, at the end of the experiment. The performance of goat was evaluated every month by weighing the animal using digital balance merk Crane scale. Blood samples were collected from a jugular vein before feeding time in the morning by using a 5 mL syringe. The blood samples collected put in a sterile tube containing EDTA anticoagulants. The glucose, triglyceride and total protein concentration were measured by using spectrophotometry with Bioenzym catalog Kit no. 139204; Kit no. 118001 and Kit no. 157092, respectively.

2.4 Statistical analysis

A completely randomized block design of experiments (blocked by BW) with 2x2 factorial design was used for the

study. Two kinds of form concentrate creep feed (mash and pellet) as first factor, and two kinds of breed (etawah crossbred and senduro) goat as second factor. The data obtained were statistically tested (ANOVA), followed by the Duncan test for difference mean treatments, using SAS versus 9.2. The significant level set at 0.05.

3. Results

The results showed that there was no interaction between the concentrate creep feed form and the goat breeds in all variables. The form of concentrate creep feed had a significant effect ($p < 0.05$) on prehension and mastication but it had no significant effect on nutrient consumption and digestibility, except for the crude fiber digestibility.

3.1 Feeding behavior

Table 2 show the data of feeding behavior of Senduro and Etawah crossbred growing goats fed with different type of concentrate creep feed. The type of concentrate pellet has significantly higher mastication compared to the mash type. On the other side, the mash type has higher prehension activity compared to the pellet type. Data showed that there were no different activities of regurgitation and re-mastication in all breed fed with concentrate creep feed.

Table 2. Feeding behavior of different growing goat breeds fed with different type of creep feed (freq./h/min)

Parameters	Treatments	Senduro	Etawa crossbred	Average ± SD
		Starter concentrate		
Prehension	Mash	162.58 ± 4.43	152.80 ± 8.12	157.00 ± 4.89[a]
	Pellet	5.19 ± 1.35	4.86 ± 1.79	5.02 ± 0.16[b]
	Ave. ± SD	83.88 ± 2.89	78.83 ± 4.95	
		Elephant grass		
	Mash	4.50 ± 0.50	5.14 ± 0.20	4.82 ± 0.32
	Pellet	4.53 ± 0.51	4.47 ± 0.13	4.50 ± 0.03
	Ave. ± SD	4.51 ± 0.015	4.80 ± 0.33	
		Starter concentrate		
Mastication	Mash	22.32 ± 14.04	37.24 ± 9.19	30.03 ± 2.9[b]
	Pellet	129.55 ± 37.24	123.75 ± 25.11	126.65 ± 7.46[a]
	Ave. ± SD	75.93 ± 11.6	80.74 ± 7.96	
		Elephant grass		
	Mash	138.06 ± 2.72	137.33 ± 1.93	137.69 ± 0.36
	Pellet	135.66 ± 2.29	133.99 ± 1.74	134.83 ± 0.83
	Ave. ± SD	136.8 ± 1.2	135.66 ± 1.67	
		Starter concentrate		
Regurgitation	Mash	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
	Pellet	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
	Ave. ± SD	0.00 ± 0.00	0.00 ± 0.00	
		Elephant grass		
	Mash	1.55 ± 0.39	1.89 ± 0.19	1.72 ± 0.17
	Pellet	1.83 ± 0.29	2.00 ± 0.00	1.92 ± 0.08
	Ave. ± SD	1.69 ± 0.14	1.94 ± 0.05	
		Starter concentrate		
Re-mastication	Mash	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
	Pellet	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
	Ave. ± SD	0.00 ± 0.00	0.00 ± 0.00	
		Elephant grass		
	Mash	56,72 ± 8,34	81,84 ± 8,38	69.27 ± 12.56
	Pellet	69.22 ± 11.54	70.11 ± 11.03	69.67 ± 0.44
	Ave. ± SD	62.97 ± 6.25	75.97 ± 5.86	

[a,b] Different superscripts within the same column are significantly different at $p < 0.05$, Ave±SD: Average ± Standard deviation

There is no activity of regurgitation and re-mastication of concentrate creep feed diet during one minute, but for elephant grass feeding activity, both of regurgitation and re-mastication were appeared. It means that the concentrate creep feed is directly go to abomasum and intestine to digest and absorb it, while the grass should be re-mastication for many times before digest and absorbed it.

3.2 Consumption and performance

Data on consumption and performance of goat showed that there were no interaction between kind of breed and type of feed in all treatments. Dry matter intake was around 3-4% of the body weight, meanwhile, the nutrient intake with 16.70 % of protein and 75% of TDN in the ration were enough to cover fast growing of indigenous goats, Senduro and Etawah crossbred. The average of protein, fiber and TDN intakes were around 147 - 154 g/h/d, 81 - 90 g/h/d and 624 - 643 g/h/d, respectively. The performance of both growing goats is shown in Table 3.

3.3 Nutrient digestibility and feed efficiency

There were no effect and no interactions between type

Table 3. Consumption and performance of different goat breeds fed with different types of concentrate (g/h/d)

Parameters	Treatments	Senduro	Etawa crossbred	Ave. ± SD
Dry matter	Mash	790.59 ± 70.29	774.20 ± 63.34	782.39 ± 8.19
	Pellet	781.88 ± 65.44	812.98 ± 55.22	797.43 ± 15.55
	Ave. ± SD	786.23 ± 4.35	793.59 ± 19.39	
Crude protein	Mash	154.88 ± 11.26	141.06 ± 10.95	147.97 ± 6.91
	Pellet	151.65 ± 13.52	157.55 ± 11.23	154.60 ± 2.95
	Ave. ± SD	153.26 ± 1.61	149.31 ± 8.24	
Ether extract	Mash	49.99 ± 3.55	45.18 ± 3.49	47.58 ± 2.40
	Pellet	48.90 ± 4.39	50.80 ± 3.64	49.85 ± 0.95
	Ave. ± SD	49.45 ± 0.54	47.99 ± 2.81	
Crude fibre	Mash	80.32 ± 11.04	95.01 ± 8.70	87.66 ± 7.34
	Pellet	81.79 ± 5.56	85.23 ± 4.97	83.51 ± 1.72
	Ave. ± SD	81.05 ± 0.73	90.12 ± 4.89	
NFE	Mash	445.48 ± 38.93	433.42 ± 35.30	439.45 ± 6.03
	Pellet	440.17 ± 37.06	457.64 ± 31.23	448.91 ± 8.73
	Ave. ± SD	442.83 ± 2.65	445.53 ± 12.11	
TDN	Mash	641.17 ± 52.14	607.43 ± 48.54	624.30 ± 16.87
	Pellet	631.17 ± 54.43	656.03 ± 45.58	643.61 ± 12.43
	Ave. ± SD	636.17 ± 5.00	631.73 ± 24.3	
ADG	Mash	175.84 ± 15.87	182.26 ± 8.06	179.03 ± 3.21
	Pellet	192.48 ± 20.48	184.41 ± 6.52	188.44 ± 4.03
	Ave. ± SD	184.14 ± 8.32	183.33 ± 1.07	

NFE: Nitrogen free extract, TDN: Total digestible nutrients, Ave ± SD: Average ± Standard deviation

of concentrate creep feed and kind of goat breeds on nutrient digestibility values, except for the crude fiber digestibility.

The crude fiber digestibility in Etawah crossbred goat was higher than Senduro. This data was presented in Table 4. Data on digestibility nutrients were quite good with average higher than 84-95 % for crude protein, extract ether and NFE, meanwhile for crude fiber was lower than 70%.

This study also showed that Senduro growing goat with pellet diet has better feed efficiency (24.80%) compared to other treatments. Etawah crossbred growing goat with mash and pellet have 23.59% and 22.72%, respectively, as mention in Figure 2.

Table 4. Nutrient digestibility of different goat breed fed with different type of concentrate (%)

Parameters	Treatments	Senduro	Etawa crossbred	Ave. ± SD
Dry matter	Mash	81.55±1.97	82.84±0.46	82.20±1.47
	Pellet	80.05±0.89	84.16±3.80	82.11±3.34
	Ave. ± SD	80.80±1.59	83.50±2.53	
Crude protein	Mash	84.20±2.14	84.07±1.97	84.14±1.84
	Pellet	83.52±1.48	85.07±3.76	84.30±2.69
	Ave. ± SD	83.86±1.69	84.57±2.74	
Ether extract	Mash	94.86±0.91	95.23±0.92	95.05±0.84
	Pellet	95.00±1.01	96.60±1.36	95.80±1.39
	Ave. ± SD	94.93±0.86	95.92±1.28	
Crude fiber	Mash	61.82±3.25	72.55±1.71	67.18±6.32
	Pellet	61.66±4.82	67.57±9.62	64.62±7.53
	Ave. ± SD	61.74±3.68[b]	70.06±6.75[a]	
NFE	Mash	85.08±1.98	85.74±0.35	85.41±1.32
	Pellet	83.04±1.00	87.68±2.77	85.36±3.15
	Ave. ± SD	84.06±1.79	86.71±2.06	

[a,b] Different superscripts within the same row are significantly different at $p < 0.0$

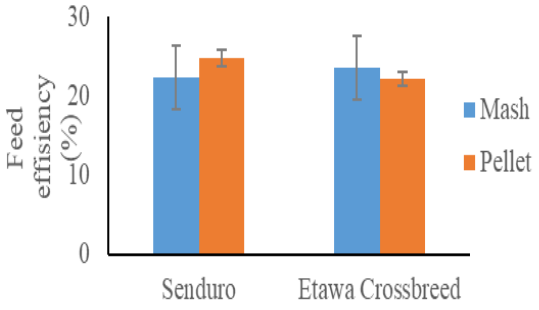

Figure 2. Feed efficiency profile of different goat breed Senduro and Etawah crossbred fed with different type of concentrate for three month

Table 5. Blood Metabolites of different goat breed fed with different type of concentrate

Blood metabolites	Treatments	Senduro	Etawa crossbred	Ave. ± SD
Glucose (mg/dL)	Mash	45.77±10.13	36.69±2.25	41.23±8.23
	Pellet	47.26±2.54	48.50±14.34	47.88±9.24
	Ave. ± SD	46.51±6.65	42.60±11.23	
Triglycerides (mg/dL)	Mash	19.97±9.95	24.72±3.43	22.35±7.14
	Pellet	21.72±3.75	19.97±14.17	20.85±9.32
	Ave. ± SD	20.85±6.79	22.35±9.58	
Total protein (g/dL)	Mash	6.41±0.25	6.38±0.28	6.40±0.24
	Pellet	6.39±0.24	6.75±0.31	6.57±0.32
	Ave. ± SD	6.40±0.22	6.57±0.34	

Ave ± SD: Average ± Standard deviation

3.4 Blood metabolites

Data on blood metabolites showed that there was no interaction effect of treatments to all blood metabolite parameters, and also there were no significance difference in the main effect of breed and type of feed to the glucose, triglycerides and total protein plasma, as presented in Table 5.

Data of plasma triglycerides and total protein showed that in all treatments (type of feed and breeds) are in the normal concentration for growing goat. The average plasma glucose concentration in all treatments were in the normal values (40 – 80 mg/dL) even though in this study are in low values[11]. The lowest plasma glucose concentration is in etawah crossbred goat with mash feeding treatment.

4. Discussion

Frequency of mastication is affected by particle size, amount of feed intake and fibre content of the ration[11]. According to Krone et al.[12] study, goat have prehension activities during morning to afternoon and rumination activities during night. Diet with mash type has smaller particle size so is easier to be consumed by the animal. It is proofed from the data with mash concentrate type, the animal eat more frequent than pellet type. On the other hand, diet with pellet type have higher regurgitation and re-mastication due to the bigger particle size to be swollen. The data in growing goat showed that the average prehension of mash concentrate diet around 157 freq./h/min, where is 30 times much higher compare to pellet one with 5 freq./h/min.

According to National Research Council[13] stated that the requirement of dry matter intake for goat with 10-20 kg is around 400-730 g/h/d. This study showed that total dry matter intake for senduro and etawah crossbred goat with 20 kg of BW fed by mash and pellet concentrate around 780-790 g/h/d, means much higher or more than enough to support their growing. The feed intake is affected by age, breed, body weight, quality of feed and type of diet. So far, National Research Council[13] recommend of protein intake around 74-167 g/h/d with estimation ADG of 100-150 g/h/d. This recommendation is match with protein intake in this study and resulted ADG of growing senduro and etawah crossbred were 179-188 g/h/d as in Table 3.

The good performance of goats in this study was support by quality of starter concentrate containing defatted BSF meal as source of protein with very good digestibility of nutrient. Data percentage of dry matter, protein, ether extract, and NFE digestibility were around 80-83%, 83-84%, 94-95%, 84-86%, respectively. The high percentage of nutrient digestibility could improve better result of metabolism, higher nutrient retained, good performance and high feed efficiency. This data also support by Astuti et al.[14] where the average ADG for growing etawah crossbred goat fed concentrate is around 206 g/h/d. Mash type feed has higher percentage crude fiber digestibility compared to pellet one[15]. The long chain fiber will be degraded by rumen microbes to be VFA as source of energy to supply nutrient for maintenance, growing, lactation and reproduction[16,17].

The feed efficiency value has indicator to evaluate the quality of ration. Senduro breed with pellet diet have better feed efficiency compared to etawah crossbreed. Growing goat of senduro breed has better palatability and efficient to utilize pellet diet. Even though data showed not significance, but etawah crossbreed has lower feed efficiency on utilization of pellet diet, that means senduro fed pellet diet has better performance compare to etawah crossbreed. According to Astuti et al.[2], feed efficiency of post weaning local goat kids fed with concentrate containing cricket meal is around 20.50. The feed efficiency value is depended on breed, feed quality, energy content, body weight and activity of the animal.

Blood metabolites measured in senduro and etawah crossbreed growing goat showed in normal range values. Glucose, triglycerides and total protein were same in all breed and all type of feed. Nutrient which is already digested will absorbed through the blood system. High digestibility of protein and fat will appear as high blood total protein (± 6 g/dL) and triglycerides (± 20 mg/dL). Data of blood glucose (± 44 mg/dL) is in normal value for ruminant. The concentration of goat blood glucose range from 42-80 mg/dL, as mention by Donald[3]. The plasma glucose and total protein from African indigenous goat were around 46-69 mg/dL and 6.60-7.80 mg/dL, respectively[18].

5. Conclusion

Eating behavior such as prehension and re-mastication were affected by type of concentrate of creep feeding. The mash type has higher prehension but lower mastication, meanwhile for the pellet type has lower prehension and

higher mastication in Senduro and Etawah crossbred growing goat. The digestibility of nutrient (except crude fiber) and ADG were same in all breeds and type of feed, and support with normal values of blood glucose, triglycerides and total protein. Therefore, more study need to compare type of creep feed on different breeds.

Declarations

Ethical consideration

The authors declare that this manuscript is original and is not being considered elsewhere for publication. Other ethical issues, including consent to publish, misconduct, fabrication of data, and redundancy, have been checked by the authors.

Competing interests

The authors declare that there have no competing interests.

Authors' contributions

This study was prepared and done by team member with specific contribution of each author. Dewi Apri Astuti was prepared the proposal, did some blood analysis and responsible to all work including preparing the manuscript. Asep Tata Permana was preparing the ration and rare animal in the pen during research. Both Rori Stevani and Tariza Ramadhania did field research including collecting data of intake, digestibility and performance. All authors have been read and approved the final manuscript.

Authors' relationships and activities

All authors are responsible for disclosing all relationships and activities that might bias or be seen to bias their work.

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Availability of data and materials

The manuscript contains all datasets generated and/or analyzed in the current study.

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