RESEARCH ARTICLE

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

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Abstract

This study was aimed to evaluate feeding behaviour, performance and nutrient utilization of goats fed different form of creep feed. Twelve local growing goats (average age 5 months, BW 20.0±1.57 kg), consisting of six Etawah crossbred and six Senduro goats were included in the study. The study was conducted in a factorial completely randomized block design of 2x2. The first factor was type of creep feed form (mash and pellet), and the second factor was type of goat breed (Etawah crossbred and Senduro). The ration consisted of 70% creep feed containing BSF (black soldier fly) meal and oil plus 30% elephant grass. The variables observed were feeding behaviour, nutrient consumption, digestibility, blood metabolites, and performance. Results showed that there was no interaction between the creep feed forms and the goat breeds in any of the variables. The form of creep feed had a significant effect ($p<0.05$) on prehension and mastication, but it had no significant effect on nutrient consumption and digestibility. The goat breeds had a significant effect ($p<0.05$) on crude fiber digestibility, being higher in Etawah crossbreds. Performance and blood metabolites were same in all treatments, except for the feed efficiency which was higher in Senduro goats than Etawahs. In conclusion, giving creep feed as pellet form resulted in a lower prehension and higher mastication, whereas mash type feed required higher prehension and lower mastication in both goat breeds.

Key words: Behaviour, Creep feed, Etawah crossbreds, Mash, Pellet, Senduro.

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Introduction

Feed is major factor to support animal production. Kinds of ingredient, quality of feed, cutting age of forage and form of feed affect the performance. Protein is dominant need to express growth rate, especially in post-weaning animals. Mostly protein source for ruminant is from legume, but sometimes it is from plant meal such as 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. Astuti and Wiryawan (2022) reported that BSF meal and its oil could be used as functional diet in ruminant. BSF contains 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 for fast growing ruminant. Creep feed is a high quality concentrate diet to support fast growth of post-weaned animals. A study by Astuti and Wiryawan (2022) has proved that the performance of the goat or sheep is better by giving BSF meal creep feed than control treatment. Giving a cricket meal in the creep feed ration for growing kids improves palatability without affecting the rumen fermentation profiles (Astuti *et al*., 2019). Eating behaviour 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 the digestibility of nutrients (Mc Donald *et al*., 2002).

Indonesia has many indigenous and crossbred small ruminant breeds. Goat population in Indonesia is more than 18.90 millions, including meat and dairy goat (Ministry of Agriculture of Indonesia, Livestock Statistic, 2020). Female dairy goats like Etawah crossbred (Etawah x local Kacang), Saanen and Senduro (Etawah x local Kacang x Jawarandu) are reared for producing milk, while the male goats are used for meat (Astuti and Laconi, 2016; Febriana *et al*., 2021). The Senduro goat is dual purpose type (Ciptadi *et al*., 2019).

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Etawah and Senduro have specific phenotypic characteristics like long ear, white and black hair and concave face (Budiarto *et al*., 2018). The senduro male have good potential as meat type due to high performance of weight gain.

Study regarding the BSF utilization as mash creep feed for Etawah crossbred and Kacang goat showed that BSF meal could substitute 100% of soybean meal in the concentrate creep feed and improve dry matter consumption and digestibility of nutrient with ADG around 110 g/h/d (Yusuf, 2019). It is a very rare data on eating behaviour of indigenous Indonesian goat, especially fed with different form of concentrate creep feed. This study was aimed to evaluate the feeding behaviour, consumption and performance, nutrient absorption and blood metabolic profiles of growing Senduro and Etawah crossbred goats fed different form of concentrate creep feed.

Materials and Methods

Study Area and Ethical Approval

The study was carried out for three months at Department of Nutrition and Feed Technology, Faculty of Animal Science, IPB University, Indonesia, following approval by the Animal Care and Use Committee (ACUC) with No. 217-2021 IPB. The proximate and blood analysis were done in the laboratory of feed technology and laboratory meat and draught animal nutrition in the same faculty.

Sample Collection

Twelve local growing goats, average 5 months age, were used in this study with average BW 20 ± 1.57 kg, consisted of six Etawah crossbred and six Senduro goats (Fig. 1 A,B). 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 was made in two form (mash and pellet) and formulated from local feedstuffs such as corn meal, pollard, soybean meal, BSF meal, BSF oil, palm kernel meal, molasses, cassava meal, $CaCO_3$, NaCl, premix and DCP. The ration (70% creep feed + 30 % elephant grass) contained 16.70% crude protein and 75% TDN. The nutrient content of concentrate creep feed and elephant grass is given in Table 1.

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

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 feeding behaviour, nutrient consumption, digestibility, daily gain and blood metabolites. CCTV Monitor was set to support data collection on feeding behaviour including prehension, rumination, regurgitation, re-mastication and fermentation, as mentioned by Nørgaard (1989). 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 (maximum scale 100 kg). Blood samples were collected from a jugular vein before feeding time in the morning by using a 5 mL syringe, and put in a sterile tube containing EDTA. The plasma glucose, triglyceride and total protein concentrations were measured by using spectrophotometry with Bioenzym catalog Kit no. 139204; Kit no. 118001 and Kit no. 157092, respectively.

Statistical Analysis

A 2x2 factorial completely randomized block design of experiment (blocked by BW) was used having two kinds of creep feed (mash and pellet) as first factor, and two kinds of goat breed as second factor. The data obtained were statistically tested (ANOVA), followed by the Duncan test for difference in mean treatments, using SAS versus 19.0.1.

Results and Discussion

The results showed that there were no significant interaction between the concentrate creep feed form and the goat breeds in any of the variables studied. The form of concentrate creep feed had a significant effect ($p<0.05$) on prehension and mastication, but not on nutrient consumption and digestibility. The goat breeds had a significant effect ($p<0.05$) on crude fiber digestibility.

Feeding Behaviour

Table 2 shows the data of feeding behaviour of Senduro and Etawah crossbred growing goats fed with different type of concentrate creep feed. Type of concentrate pellet had significantly higher mastication compared to the mash

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

Parameters	Feed	Treatments	Senduro	Etawa crossbred	Av. ± SD
Prehension	Starter concentrate	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]
		Av. ± 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
		Av. ± SD	4.51 ± 0.015	4.80 ± 0.33	
Mastication	Starter concentrate	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]
		Av. ± 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
		Av. ± SD	136.8 ± 1.2	135.66 ± 1.67	
Regurgitation	Starter concentrate	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
		Av. ± 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
		Av. ± SD	1.69 ± 0.14	1.94 ± 0.05	
Re-mastication (Rumination)	Starter concentrate	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
		Av. ± 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
		Av. ± SD	62.97 ± 6.25	75.97 ± 5.86	

[a,b]Different superscripts within the same column differ significantly at $p<0.05$

type. On the other side, mash type had higher prehension activity compared to the pellet type. However, there were no differences in activities of regurgitation and re-mastication in both breed fed with concentrate creep feed. There was no activity of regurgitation and re-mastication of 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 directly goes to abomasum without re-mastication, and intestine to digest and absorb it, while the grass should be re-masticated for many times before it is digested and absorbed. Frequency of mastication is affected by particle size, amount of feed intake and fibre content of the ration. According to Krone *et al*. (2024), goats have prehension activities during morning to afternoon and rumination activities during night. Diet with mash type has smaller particle size so it is easier to be consumed by the animal. It is proved from the data with mash concentrate type, the animal eats more frequent than pellet type. On the other hand, diets 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 was around 157 freq./h/min, which is 30 times higher compared to pellet one with 5 freq./h/min.

Consumption and Performance

Data on nutrient consumption and performance of goats showed that there were neither significant effect of main factors, *i.e.,* kind of breed and type of feed nor their interactions on various nutrient intake. Dry matter intake was around 3-4% of the body weight. The average of total protein, fibre and TDN intakes were around 147-154 g/h/d, 81-90 g/h/d, and 624-643 g/h/d, respectively. The nutrient intake with 16.70 % protein and 75% TDN in the ration were enough to cover fast growth of indigenous goats, Senduro and Etawah crossbreds. The performance of both growing goats shown in Table 3 also did not vary between kind of breed and type of feed.

According to National Research Council (NRC, 2007) dry matter intake for goat with 10-20 kg is around 400-730 g/h/d.

Table 3: Consumption and performance of different goat breed fed with different type of concentrate

Parameters	Treatments	Senduro	Etawa crossbred	Ave. ± SD
Dry matter (g/h/d)	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 (g/h/d)	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 (g/h/d)	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 (g/h/d)	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 (g/h/d)	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 (g/h/d)	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 (g/h/d)	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	

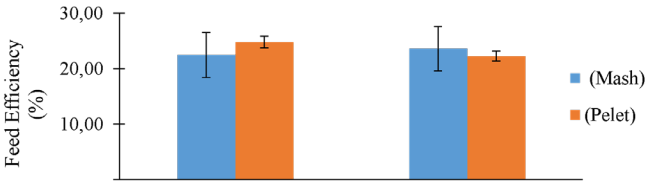

Fig. 2: Feed efficiency profile of different goat breed fed with different type of feed

This study showed that total dry matter intake for Senduro and Etawah crossbred goats with 20 kg BW fed by mash and pellet concentrate was around 780-790 g/h/d, which is much higher or more than enough to support their growth. The feed intake is affected by age, breed, body weight, quality of feed and type of diet. So far, NRC (2007) recommend protein intake around 74-167 g/h/d with estimated ADG of 100-150 g/h/d. This recommendation matches with protein intake in this study and resulted ADG of 179-188 g/h/d in growing Senduro and Etawah crossbreds (Table 3).

Nutrient Digestibility and Feed Efficiency

There were no effects of type of concentrate creep feed and kind of goat breeds or their interactions on nutrient digestibility values, except for the crude fiber digestibility, which was higher in Etawah crossbred goat than Senduro (Table 4). Data on digestibility of nutrients were quite good with average higher than 83-95 % for crude protein, extract ether and NFE, while for crude fiber it was lower than 70%. The data is comparable with fibre digestibility in goat reported by Lu *et al.* (2005). This study also showed that growing Senduro goat on pellet diet had better feed efficiency (24.80%) compared to other treatments. The good performance of goats in this study was supported by quality of starter concentrate containing defatted BSF meal as a source of protein with very good digestibility of nutrient. The high percentage of nutrient digestibility could improve metabolism, higher nutrient retained, good performance and high feed efficiency. This data also supported the findings of Astuti *et al.* (2000), where the average ADG for growing Etawah crossbred goats fed concentrate was around 206 g/h/d. Mash type feed has higher percentage crude fiber digestibility compared to pellet one (Porter *et al.,* 2007).

Growing Etawah crossbred goats with mash and pellet had 23.59% and 22.72% feed efficiency, respectively (Fig. 2).

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

Parameters	Treatments	Senduro	Etawa crossbred	Av. ± 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
	Av. ± 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
	Av. ± 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
	Av. ± 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
	Av. ± 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
	Av. ± SD	84.06±1.79	86.71±2.06	

^{a,b}Different superscripts within the same row differ significantly at $p<0.05$.

Table 5: Blood metabolites of different goat breed fed with different type of concentrate

Blood metabolites	Treatments	Senduro	Etawa crossbred	Av. ± 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
	Av. ± 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
	Av. ± 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
	Av. ± SD	6.40±0.22	6.57±0.34	

The feed efficiency value is an indicator to evaluate the quality of ration. Senduro breed with pellet diet had better feed efficiency compared to Etawah crossbreed for better palatability and efficient utilization of pellet diet. Even though data showed non-significant difference, Senduro fed pellet diet had better performance compared to Etawah crossbreed. According to Astuti *et al.* (2019), feed efficiency of post-weaned local goat kids fed with concentrate containing cricket meal was around 20.50. The feed efficiency value depends on breed, feed quality, energy content, body weight and activity of the animal.

Blood Metabolites

Data on blood metabolites showed that there were neither significance differences in the main effects of breed and type of feed nor their interaction effect on the plasma glucose, triglycerides and total protein (Table 5), and the values of plasma triglycerides and total protein were within the normal value for growing goats, while the average plasma glucose concentrations in all treatments were in the lower range of normal values (40-80 mg/dL, Mc Donald *et al.,* 2002). The lowest plasma glucose concentration was in Etawah crossbred goats with mash feeding treatment. Pambu-Gollah *et al.* (2000) reported the plasma glucose and total protein from African indigenous goat around 46-69 mg/dL and 6.60-7.80 mg/dL, respectively.

Conclusion

Eating behaviour of Senduro and Etawah crossbred growing goats such as prehension and re-mastication was affected by type of concentrate creep feed. The mash type had higher prehension, but lower mastication, while for the pellet type feed there was lower prehension and higher mastication in both the breeds. The digestibility of nutrient (except crude fiber) and ADG were same in all breeds and type of feed,

with normal values of blood glucose, triglycerides and total protein.

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