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Effects of Diets Containing *Asyastasia gangetica* and *Brachiaria decumbens* on Intake, Digestibility and Growth Performance of Growing Rabbits

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ABSTRACT

The beneficial effects of feeding rabbits with forages have been recommended. However, limited study has been made on feeding values of locally available forages in rabbits. Therefore, an experiment was conducted to evaluate the effect of *Asyastasia gangetica* and *Brachiaria decunbens* on intake, digestibility, and growth performance of rabbits. Twelve rabbits were distributed into three diets: (i) 100% commercial pellet as control (T1), (ii) 50% pellet plus *Asyastasia gangetica ad libitum* (T2), and (iii) 50% pellet plus *Brachiaria decumbens ad libitum* (T3). Daily feed intake, nutrient digestibility, weekly body weight, and feed conversion ratio (FCR) were measured. Intakes of total dry matter (DM) (121.2-134.3 g/d) and organic matter (OM) (115.1-132.5 g/d) were similar (p>0.05) for all the groups. The crude protein (CP) intake of rabbits fed with T1 (10.1 g/d) and T3 (9.6 g/d) diets was similar (p>0.05), but lower (p<0.05) than T2 (14.1 g/d) diet. Ether extract intake of rabbits fed with T2 (2.9 g/d) and T3 (3.9 g/d) diets was similar (p>0.05), but lower (p<0.05) than T1 (5.1 g/d) diet. Neutral detergent fibre (NDF) intake was higher (p<0.05) for rabbits fed with T3 (55.8 g/d) diet followed by T2 (41.7 g/d) and T1

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(31.7 g/d) diets. There were no differences (p>0.05) on the digestibilities of DM, OM, and CP among treatments. Total weight gain and daily weight gain were higher (p<0.05) for rabbits fed with T1 (568 and 11.0 g) and T2 (468 and 9.0 g) diets than T3 (155 and 3.3 g) diet, respectively. The lowest FCR was obtained with T1 (12.3) and T2 (13.9) diets, whereas the highest was obtained with T3 (30.3) diet. In conclusion, diet containing *Asyastasia gangetica* showed more benefits in terms of CP and NDF intakes, weight gain and FCR than the diet containing *Brachiaria decumbens*. A combination of concentrate and *Asyastasia gangetica* is recommended as a partial replacement for concentrate in rabbit production.

Keywords: *Asyastasia gangetica*, *Brachiaria decumbens*, digestibility, growth performance, intake, rabbit

INTRODUCTION

Rabbit farming is gaining popularity in smallholder farmers as an alternative source of animal protein. Rabbit is considered as one of the suitable high quality animal proteins in developing countries (Owoleke et al., 2016). Smallholder farmers get faster benefits from rabbit farming compared to other farming systems (e.g., cattle farming), because rabbits require low investment, show short generation interval and have the ability to consume forage grasses. For profitable rabbit production, feed is considered as one of the most important inputs. When rabbits receive feeds containing required amount of energy and protein, they can provide better quality meat as a healthy diet for human consumption. Production of high quality meat at lower prices is achievable when locally available forage plants are included in rabbit's diet.

Safwat et al. (2014) stated that many forages could be used in ration formulation by replacing the costly protein sources. It depends on the forages' chemical composition, viability, palatability, and anti-nutritional factors. Rabbits fed leaves of browse plants and concentrate showed better performance than those fed tropical grasses with concentrate as reported by Amata and Okorodudu (2016). Adigun et al. (2014) also reported that 66% of wheat offal could be replaced with *Asyastasia gangetica* leaf meal as a fibre source in the diet of rabbit.

Asyastasia gangetica could be used as a substitute for legumes as reported by Adetula (2004). It is considered as suitable protein and mineral sources for goats (Khalil, 2016). Because of its ability to fast-grow naturally, resulting in low production cost, and high nutritive value, *A. gangetica* is utilised as forage for ruminants in South-East Asia; it is either grazed or cut for stall feeding (Gopal et al., 2013). Besides having these attributes, this plant can tolerate shade well. It grows prolifically in Malaysia especially at shaded and plantation areas (Chuku et al., 2018). Most of the farmers also feed their livestock with forages like *Brachiaria decumbens*. In Malaysia, *B. decumbens* is being used as a main plant in farming pasture and it is the most favored species for grazing ruminants (Low, 2015).

However, level of concentrate offered to rabbits should not be below 50% (50g) when fed with bracharia hay as recommended by Iyeghe-Erakpotobor et al. (2006), and poor utilisation of bracharia hay in their study was observed especially when offered low concentrate level.

However, there is little information about the effect of these locally available forage grasses on rabbit performance. It is important to know about the nutrient status of above mentioned forages as it can support the production and growth of rabbits. Therefore, this study was conducted to compare the feeding effect of two local tropical forage grasses (*Brachiaria decumbens* and *Asyastasia gangetica*) with supplementation of concentrate on intake, nutrient digestibility, growth performance, and feed conversion ratio of weaned rabbits.

MATERIALS AND METHODS

Study Site and Experimental Design

An experiment with rabbits was carried out in rabbit house located at Agro Techno Park, Universiti Malaysia Kelantan (UMK), Jeli campus, Kelantan. All animal handling and procedures were approved by the UMK Animal Care and Use Ethics Committee (UMK/FIAT/ACUE/UG1/2018). The average daily temperature and monthly rainfall were 28°C and 260 mm during the experimental period (July – October 2019).

The experiment was conducted for 69 days (10 days as an adaptation period, 52 days as a growth trial and 7 days as a collection period) using twelve unsexed weaned mixed breed rabbits, about 2 months of age, which were obtained from local supplier. Before data collection, rabbits with an initial average body weight (BW) of 1080.8±275.4 g were adapted to the new enviroment for 10 days, when only commercial pelleted compound feed were offered them on *ad libitum* basis (140 g/head/d). During adaptation period, the average daily pellet intake was 116.7±11.4 g/head, which was about 11.0% of initial their BW. Based on these data, all rabbits with an average BW of 1175.3±287.8 g were divided into three dietary groups consisting of 4 rabbits of each: (i) commercial pelleted compound feed on *ad libitum* (11.0% of their BW) basis which was served as control (T1), (ii) half of the control (5.5% of their BW) plus *Asyastasia gangetica* on *ad libitum* (75 g dry matter/head/d) basis (T2), and (iii) half of the control (5.5% of their BW) plus *Brachiaria decumbens* on *ad libitum* (83 g dry matter/head/d) basis (T3). Throughut the experimental period, the quantities of offered pellet (for T1), *Asyastasia gangetica* (for T2) and *Brachiaria decumbens* (for T3) were adjusted weekly to ensure at least 20% refusals. The quantities of offered pellet for T2 and T3 treatments were determined for individual rabbit on the basis of their BW, and adjusted weekly to account for BW changes. The pellet and grasses were offered in separate feeders. Water was supplied *ad libitum* in automatic pipe drinkers.

Both types of grass were harvested at pre-flowering stage daily in the morning from the experimental field of Agro Techno Park, UMK, and fed to rabbits as fresh basis. The commercial pelleted compound feed prepared by feed manufacturing company (Perniagaan Hasbin Jaya, Pulau Pinang, Malaysia) was purchased from a local supplier,. The feeds were offered to rabbits twice in the morning (8:00 am) and again in the afternoon (4:00 pm).

Approximate ME from daily offered pellet and grasses for T1, T2, and T3 diets were 2490.4, 2650.7, and 2266.3 kcal/kg DM, respectively. Similarly, approximate CP from daily offered pellet and grasses for T1, T2, and T3 diets were 7.5, 11.8, and 7.8%, respectively. The ME and CP values in rabbit's diet should be 2025 kcal/kg DM and 16.0%, respectively, to meet the requirements of a growing rabbit, according to National Research Council (NRC) (1977). It seems that the quantities of energy in the diets were more than required, but the CP contents in the diets were low. It was hypothesized that rabbits could take the rest of the CP from daily offered *ad libitum* pellet or grasses.

The ingredients used in the diets and their chemical compositions are shown in Table 1. Daily feed offered and refusals were recorded to estimate feed intake, and their samples were taken once a week for determining dry weight. Before feeding, rabbits were weighed at the beginning of the experiment, at 1-week interval and at the end of the experiment. Average daily gain and feed conversion ratio (FCR) were calculated to see the difference between the treatments on rabbit's performance as described by Biobaku et al. (2003). The FCR was calculated using dry matter (DM) intake by dividing the body weight (BW) gain. During the collection period, samples of offered feeds, refusals and faeces were collected and stored in a freezer. At the end of collection period, the collected faeces samples from each rabbit were thawed and mixed together to get a representative sample.

Chemical Analysis

Samples of feeds and faeces were analysed to determine the DM, crude protein (CP), ether extract (EE), and ash contents according to Association of Official Analytical Chemists (AOAC) (2000). Neutral detergent fibre (NDF) of feeds was determined following the method of Van Soest et al. (1991).

Statistical Analysis

All data were analysed through one-way ANOVA using SPSS software. They were compared between treatments using Duncan's multiple range test (DMRT) at $p<0.05$.

RESULTS AND DISCUSSION

Proximate Components

Asyastasia gangetica and *Brachiaria decumbens* contained 15.5 and 20.9% dry matter (DM), 85.7 and 92.2% organic matter (OM), 15.9 and 8.1% crude protein (CP), 1.4 and 2.8% ether extract (EE), 45.9 and 63.1% neutral detergent fibre (NDF), as well as 14.3 and 7.8% ash, respectively. The commercial pelleted compound feed contained 85.1% DM, 98.6% OM, 7.5% CP, 3.8% EE, 23.6% NDF, and 1.4% ash (Table 1). The DM content of the commercial pellet was higher than those of the forages. The CP content of the commercial pellet was similar with the value of *B. decumbens* but not with *A. gengetica* which had a higher value (15.9%). *Asyastasia gangetica* also showed higher ash contents than the value of *B. decumbens*. In contrast, the *B. decumbens* contained comparatively higher DM, OM, EE, and NDF contents than the respective values of *A. gangetica* (Table 1). The CP content in *A. gangetica* in this study was lower than the findings of Adigun et al. (2014), who reported that the leaf meal from *A. gangetica* contained 19.3% CP. This variation may have resulted due to the use of different aged plants, because the nutrient contents in plants can be varied by plant maturity (Suhaimi et al., 2017). Besides, the differences in climate, rainfall and temperature of studied area are considered as factors that contribute in variation of CP content in plants.

Asyastasia gangetica contained 15.9% CP in this study, making it suitable to replace conventional protein sources in rabbit's diet. Owoleke et al. (2016) reported that CP needed by rabbit was about 16-18%, but 15-16% was also recommended for growing rabbit. In another study, Cheeke (1987) suggested that adult rabbits required about 12% of CP, 14% of crude fibre, and 2% of EE daily. This means that *A. gangetica* contains lower EE (1.4%) than the daily EE requirment of rabbits.

Suhaimi et al. (2017) reported that the CP content of *B. decumbens* was about 9-20%; and this value declined as the plant aged. Thus, the low CP content of *B. decumbens* found in this study (Table 1) may have resulted due to the usage of aged plants. Similarly, the NDF content in *B. decumbens* in this study was lower (63.0 vs. 69.2%) than the findings of Silva et al. (2016) respectively, which can

Table 1
Chemical composition (%) of the feed ingredients

Nutrients	Commercial pellet	*Asystasia gangetica*	*Brachiaria decumbens*
Dry matter	85.1	15.5	20.9
Organic matter	98.6	85.7	92.2
Crude protein	7.5	15.9	8.1
Ether extract	3.8	1.4	2.8
Neutral detergent fibre	23.6	45.9	63.1
Ash	1.4	14.3	7.8
Metabolisable energy (kcal/kg dry matter)$^{\beta}$	2490.4	2800.6	2076.9

Note. $^{\beta}$ Data obtained from the secondary data (Biobaku et al., 2003; Sobayo et al., 2012; Suhaimi et al., 2017) also be explained due to the differences in plant maturity and location of studied areas. Besides other nutrients, NDF is also important in rabbit's diet; the NDF value of commercial pellet was much lower than those of the forages, which is a positive trait as excess NDF content (>60%) can affect negatively on total DM intake in animals (Mertens, 1997). Nevertheless, rabbit has the ability to utilise the NDF efficiently due to the presence of microorganisms in their caecum.

The ash content of commercial pellet was lower than those of the forages. The ash content in *A. gangetica* was much higher than the *B. decumbens*, which can provide more minerals to the animal compared to other feed ingredients used in this study. When formulating rabbit's diet, the percentage of all nutrients must be taken into account to fulfill the nutrient requirments of rabbit.

Dry Matter and Nutrients Intakes

The feeding effect of *A. gangetica* and *B. decumbens* on daily intakes of DM and other nutritional components by rabbits is given in Table 2. Rabbits fed with T3 diet showed higher daily forage DM intake than those fed with T2 diet, whereas there was no difference on daily pellet DM intake between rabbits fed with T2 and T3 diets as their diet of commercial pellet was the same. However, replacement of half of commercial pellet by offering of test forages on *ad libitum* basis did not affect (p>0.05) the daily total DM and OM intakes by rabbits, which suggests that test forages have potential to be used as feed in rabbit's diet. This result is in agreement with Amata and Okorodudu (2016), who stated that 50:50 mixtures of concentrate (maize) and forage (*Centrocema pubescens*) led to maximum performance in rabbit. The optimum total DM and OM intakes in this study were achieved when rabbits fed with test forages *ad libitum* in combination with 50% concentrate. A certain ratio of these forages to concentrate may give optimum rabbit performance that could lead to reduced feed cost.

Rabbits fed with T2 diet showed significantly (p<0.05) higher (14.1 g/d) CP intake followed by rabbits fed with T1 (10.1 g/d) and T3 (9.6 g/d) diets, whereas no influence of CP intake was observed between rabbits fed T1 and T3 diets. This may be explained due to the lower CP contents in both commercial pellet and *B. decumbens* compared to *A. gangetica* (Table 1). Thus, *B. decumbens* can be considered as an unsuitable protein source in rabbit's diet as supply of plenty of T3 diet had no influence on rabbit's CP intake.

Khalil (2016) reported that *A. gangetica* was a suitable complementary protein and mineral source for goat. Therefore, it is also a good complementary feed for rabbit because of high CP value. Nowadays, chicken and beef meat are being replaced with rabbit meat in human diet because of its high quality protein; nevertheless rabbits require adequate amount of protein in their diet for maintenance and growth.

Rabbits fed with T1 diet showed higher (5.1 g/d) EE intake followed by T3 (3.9 g/d) and T2 (2.9 g/d) diets, which

Table 2

Feed intake and digestibility of nutritional components by rabbits fed commercial pellet with or without Asystasia gangetica *and* Brachiaria decumbens

Parameter	Treatment			*p*-value
	T1	T2	T3	
Intake (g/d)				
Grass DM	0.0[c] ±0.0	62.0[b] ±4.0	68.9[a] ±4.0	0.000
Pellet DM	134.3[a] ±27.0	53.8[b] ±7.1	52.3[b] ±3.1	0.000
Total DM	134.3 ±27.0	115.8 ±9.4	121.2 ±4.9	0.360
Total OM	132.5 ±26.6	107.5 ±9.1	115.1 ±4.7	0.144
Total CP	10.1[b] ±2.0	14.1[a] ±0.9	9.6[b] ±0.4	0.020
Total EE	5.1[a] ±1.0	2.9[b] ±0.3	3.9[b] ±0.2	0.003
Total NDF	31.7[c] ±6.4	41.7[b] ±2.7	55.8[a] ±2.6	0.000
Digestibility (%)				
DM	52.5 ±6.2	58.0 ±1.9	49.1 ±6.0	0.092
OM	63.0 ±4.4	63.4 ±1.7	56.6 ±5.2	0.081
CP	71.6 ±3.4	70.9 ±1.7	68.5 ±3.3	0.328

Note. [abc] means with different superscripts in a row differ significantly ($p<0.05$). T1 = control diet containing 100% commercial pellet; T2 = half of the control diet plus *Asystasia gangetica* on *ad libitum* basis; T3 = half of the control diet plus *Brachiaria decumbens* on *ad libitum* basis. DM = dry matter; OM = organic matter; CP = crude protein; EE = ether extract; NDF = neutral detergent fibre

could be reflected due to the higher EE content in commercial pellet than other treatments containing test forages. There was no significant ($p>0.05$) difference on EE intake between the rabbits fed with T2 and T3 diets. Although total DM intake was reduced with increasing levels of EE in rabbit's diet as reported by Choi and Palmquist (1996), there was no influence on total DM intake among the treatments in the present study. This could be due to the presence of optimum level of EE in the experimental diets, which might be lower than the maximum level acceptable for use in rabbit's diet preventing adverse effect on their DM intake.

Total NDF intake increased ($p<0.05$) as commercial pellet was replaced by test forages. Rabbits fed T3 diet showed higher (55.8 g/d) NDF intake followed by T2 (41.7 g/d) and T1 (31.7 g/d) diets. This was attributed due to the use of different feed ingredients in the diets that contained different NDF contents (Table 1). Assis et al. (2019) reported that the NDF intake by animals could be increased when the energy density of the diet was low.

The DM and nutrient digestibility by the rabbits fed on different treatments are shown in Table 2. Similar to total DM and OM intakes, no influence ($p>0.05$) of experimental diets was observed on the digestibility of nutritional fractions. The DM digestibility for T3 diet containing *B. decumbens* is in line with the findings of Roeder (n.d.), who reported that the DM digestibility of timothy hay was 49.1%. The DM digestibility of alfalfa hay was higher (50.7%) compared to the current DM digestibility of T3 diet, but it was lower compared to the T2 diet (58.0%). This suggests that T2 or T3 diet containing test forages had better DM digestibility when compared to other common forages that were fed to rabbits. Thus, when combining concentrates with forages, not only can it reduce the feed cost but also lead to use of locally available forages. Moreover, it can reduce dependency on the imported feeds such as timothy, alfalfa and other common forages.

Rabbits fed with T1 diet showed the highest CP digestbility (71.6%), while those fed with T3 diet showed the lowest (68.5%). Purwin et al. (2019) found that the CP digestibility of dehydrated alfalfa meal was 71.8%, which is in line with the current study. With increasing demand on animal protein, rabbit is suitable to be reared because of its high ability to convert forage into meat, low cost of production, and high quality protein meat (Amata & Okorodudu, 2016). Non-significant digestibility in DM, OM, and CP among treatments was found in this study which indicated that the rabbits were able to utilise nutrients from the concentrate, or the combination of concentrate and test forages.

Growth Performance

Effect of the experimental diets on initial BW, final BW weight, average daily gain, and FCR are presented in Table 3. The average final BW of rabbits among treatments ranged from 1200 g to 2130 g. The final BW was not influenced ($p>0.05$) by the diets. Rabbits fed with T1 diet showed the highest final BW, while rabbits fed with T3 diet showed the lowest. This result might be attributed to the fact that there was no effect of diets on the DM intake by the rabbits. Individual BW of rabbit for marketing is about 1.9-2.0 kg for White New Zealand or Chinchillia breed; less than this BW is considered to be in low quality. Average final BW of rabbit from T1 diet showed closer weight to the required market weight of rabbit. In the current study, low BW was achieved, and this result may have been caused by the use of mixed breed.

Unlike the final BW, the average total weight gain and the daily weight gain were affected ($p>0.05$) by the diets. The significantly highest BW gain and the lowest FCR were obtained with the T1 and T2 diets, whereas the significantly lowest BW gain and the highest FCR were obtained with the T3 diet. This result may have possibly been because of the significant effect of diets on the intake of CP, EE, and NDF. Rabbits fed with T3 diet showed lower BW gain, which might be due to the high fibre content, coarseness, and high DM content of the *B. decumbens*. Iyeghe-Erakpotobor et al. (2006) observed that 25% levels of soybean cheese waste/maize offal diet

Table 3

Growth performance of rabbits fed commercial pellet with or without Asystasia gangetica *and* Brachiaria decumbens

Parameter	Treatment			*p*-value
	T1	T2	T3	
Initial weight (g)	1178 ±374	1183 ±312	1165 ±258	0.997
Final weight (g)	1745 ±416	1650 ±216	1320 ±159	0.143
Total weight gain (g)	568^{a} ±61	468^{a} ±132	155^{b} ±106	0.001
Daily weight gain (g)	11.0^{a} ±1.4	9.0^{a} ±2.7	3.3^{b} ±2.2	0.002
FCR	12.3^{b} ±1.8	13.9^{b} ±4.4	30.3^{a} ±4.0	0.000

Note. ^{ab} means with different superscripts in a row differ significantly (p<0.05). T1 = control diet containing 100% commercial pellet; T2 = half of the control diet plus *Asystasia gangetica* on *ad libitum* basis; T3 = half of the control diet plus *Brachiaria decumbens* on *ad libitum* basis; FCR = feed conversion ratio

group lost body weight (-2.08 g/d) when fed with bracharia hay. In another study, Asuquo (1997) also reported that differences in BW and rate of weight gain of rabbits could be attributed due to the differences in the nutrient composition of the supplied forages. Although *B. decumbens* is palatable to rabbits, it contains saponins, an anti-nutrient. However, Faccin et al. (2016) reported that rabbits were not vulnerable to *Brachiaria* poisoning with concentrations of saponins that are toxic to sheep.

Rabbits fed with T1 and T2 diets had similar values of FCR, but their values were lower significantly (p<0.05) than the values of those fed T3 diet. The lower values of FCR implies that the rabbits were able to convert the concentrate and *A. gangetica* forage more efficiently to meat. The rates of daily weight gain in rabbits fed with T1 and T2 diets in this study were in line with daily growth of 5-10 g in growing rabbits as reported by Iyeghe-Erakpotobor et al. (2001) under tropical conditions.

CONCLUSION

Overall, the commercial pellet and the diet containing *Asyastasia gangetica* showed almost similar results. It is recommended for use a diet consisting of half of the concentrate and *A. gangetica ad libitum*. Not to mention that diet cintaining *Brachiaria decumbens* instead of *A. gangetica* can also be an alternative, but it is less suggested because lower rate of BW gain may occur. In rural areas where *A. gangetica* and *B. decumbens* forages are available, these could be efficiently utilised for feeding growing rabbits.

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