Nutritive value, palatability and selectivity of 10 different legume herbages by rabbits

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Abstract

This experiment was conducted to determine the nutritive value, palatability and selectivity of 10 legume herbages by rabbits. Chemical analyses and legume intake by rabbits were evaluated for the suitability to fully or partially replace commercial rabbit diet. Ten species of legumes: *Desmodium triflorum, Clitoria ternatea, Stylosanthes guianensis, Calopogonium mucunoides, Albizia falcate, Albizia saman, Centrosema pubescens, Leucaena leucocephala, Indigofera zollingeriana* and *Arachis pintoi* were analysed for nutrient content. The legumes were analysed for proximate analysis which included dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE) and ash (OM). Two methods of feed preference testing were carried out to evaluate the acceptability and preference of the 10 legume species by the rabbits. Five New Zealand White female adult rabbits aged more than 1 year old were allocated to individual cages. The first trial was a single bowl test in which one legume species was offered to each rabbit daily and evaluated for acceptability. The second trial was a double bowl test in which two species of legumes were presented to each rabbit at the same time and evaluated for preference. The testing period for each method lasted for 9 to 10 d, preceded by one week of adaptation. The proximate analysis results showed that all legume herbages had high nutrient, such as CP content. *Indigofera zollingeriana* had the highest CP content and *Calopogonium mucunoids* had the highest CF content compared to other legumes and commercial pellet feed. Meanwhile from the feed preference trials, *Arachis pintoi, Indigofera zollingeriana and Centrosema pubescens* were the most preferred legumes while *Albizia saman* was the least preferred by the rabbits. It can be concluded that not all legumes are suitable to fully replace commercial diet in rabbits, thus suggesting that legumes can be combined with other forages, and both forages and commercial feed can be included in diets for a successful rabbit production.

Keywords: feed preference, palatability, nutritive value, legumes, rabbits

Introduction

In developing countries, rabbits are potential meat-producing animals and have a great opportunity for expansion in the tropics. This is because of their minimal investment requirements, short generation interval and low feed requirement, especially with regard to demand for grain. Rabbits are grazers and browsers so they require and consume low amount of feed per day in natural conditions. They are herbivores and can be successfully raised on low grains and high roughage diets. Their housing and disease control management requirements are also low yet they are able to produce meat which is highly nutritious and healthier source of protein compared to other sources of meat. Furthermore, rabbits have small body size, high reproductive potential, rapid growth rate and the ability to utilise forages.

For a successful production of rabbits, one of the important inputs is the rabbit's feed. The major nutritional requirements of rabbits of concern in small-scale tropical rabbit production are protein and energy. When properly fed, they can provide a high protein low fat meat for healthy eating. However, the demand to produce high quality rabbit production at lower prices has caused the alternative feed resources such as tropical plants, legume herbages to be used in rabbit's diet. Legumes are high in protein which is a fundamental component of animal tissue and help in development of muscles, cell tissue, certain hormones and all enzymes. The use of these tropical plants which are not directly used by humans as food to feed rabbit is one of the ways to reduce the production cost and make protein available at lower prices.

Thus, investigating the possible utilization of a variety of forages as rabbit diets is importance. Many evaluation of the nutritive value of such plants has been conducted and most palatability and selection trials have focused on single or double bowl forage evaluation. Thus, the objective of this study was to determine the nutritive value, palatability and selectivity of 10 different legume herbages by rabbits.

Materials and Methods

Experimental materials

This study was conducted from of August to October, 2017 at the Nutrition Laboratory and Field Laboratory, Faculty of Agriculture, Universiti Putra Malaysia, Serdang, Selangor. In this study, the experimental animals were obtained from Makmal Ladang 15, weighed and placed separately into 5 individual rabbit cages (40 x 60 x 50 cm) with similar environment provided (ambient temperature and relative humidity), space between cages, feeding and drinking management. There were 10 species of legume herbages which are *Desmodium triflorum, Clitoria ternatea, Stylosanthes guianensis, Calopogonium mucunoides, Albizia falcate, Albizia saman, Centrosema pubescens, Leucaena leucocephala, Indigofera zollingeriana and Arachis pintoi* used in this experiment. All of these legumes were harvested from the area within UPM campus.

Proximate analysis

For evaluation of nutritive value, a laboratory test was carried out on the 10 selected legume herbages and commercial rabbit feed pellets, each with five replicates. Using proximate analysis, the legumes and rabbit feed pellets were analysed for dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE) and ash (OM) according to AOAC (1995). The nitrogen percentage was measured for the protein content using Kjeldahl method. The crude protein was calculated by multiplying the nitrogen percentage with conversion factor of 6.25. The chemical composition of legumes and rabbit feed pellets was compared.

Legumes palatability evaluation and selection

The legumes palatability evaluation and selection by rabbits were conducted with two trials: single bowl and double bowl tests. The single bowl test required 17 d; 7 d as an adaptation period and 10 d as a testing period. Each rabbit was offered 25g of fresh cut a legume species every day, where the test was administered in the morning. The bowl was left with the rabbit for a set duration of time, commonly 15 to 30 min or until the bowl content was completely consumed (Aldrich and Koppel, 2015). The time taken by the rabbit to completely consume the given legume and the total

weight of the legume consumed were recorded daily (each day each rabbit was offered one species of legume) (Aldrich and Koppel, 2015).

The double bowl test was done in 16 d; 7 d as an adaptation period and 9 d as a testing period. Each of the 5 rabbits was offered 2 species of legumes per day, (testing period day 1 to 3) in 2 bowls. The test was administered in the morning, where the two species of legumes weighing 20g each were presented simultaneously to the rabbit. The bowls were left with the rabbits for a set duration of time, commonly 15 to 30 min or until one of the bowls was completely consumed (Aldrich and Koppel, 2015). The preference of the rabbits between the two species of offered legumes was observed. The palatability of the legume was determined by taking the difference from two initial weights of the legume samples given on offer and orts (or leftovers). On day 3 of the testing period, legumes with high palatability and selection by rabbits were determined (Fernández-Carmona, 2005).

Statistical analysis

All data collected were tabulated using Microsoft Excel and analysed using Statistical Analysis Software (SAS) 9.4 program to compute analysis for variance (ANOVA), for a cross over design and the significant differences between means were done according to Duncan's Multiple Range Test (DMRT) and statistical significance was considered at $P<0.05$.

Results and Discussion

The chemical composition of 10 species of legumes and pelleted commercial feed (PCF) obtained from proximate analysis are shown in Table 1. There were significant differences ($P<0.05$) among 10 legume species for DM, OM, CP and CF but no significant difference for EE. Compared to PCF, most legumes had higher CP and CF content.

Table 1. Chemical composition of forage legumes and pelleted commercial feed (n=5 replicates of sample for each legume).

Legumes	Parameter				
	Dry Matter (%)	Ash (%)	CP (%)	CF (%)	EE (%)
D. triflorum	33.46±0.03^{b}	2.75±0.00^{h}	16.58±0.25^{bc}	24.73±1.43^{c}	1.61±0.67^{a}
C. ternatea	18.61±0.02^{j}	4.98±0.00^{a}	25.48±6.32^{ab}	20.85±0.67^{e}	1.92±0.79^{a}
S. guianensis	27.06±0.07^{h}	3.40±0.00^{c}	16.77±1.02^{bc}	29.83±0.22^{b}	1.88±0.79^{a}
C. muconoids	29.18±0.02^{g}	3.13±0.01^{e}	15.43±0.05^{c}	35.24±0.92^{a}	1.97±0.82^{a}
A. falcate	35.46±0.00^{a}	2.64±0.00^{i}	17.69±4.36^{bc}	23.96±0.58^{cd}	3.25±1.33^{a}
C. pubescens	33.11±0.01^{c}	2.88±0.00^{g}	17.06±4.18^{bc}	31.87±1.09^{b}	1.71±0.70^{a}
L. leucocephala	32.59±0.01^{d}	2.61±0.00^{j}	14.28±3.49^{c}	12.15±1.00^{g}	2.80±1.15^{a}
A. saman	29.46±0.01^{f}	3.25±0.00^{d}	31.56±0.17^{a}	19.08±0.81^{ef}	1.82±0.75^{a}
I. zollingeriana	25.61±0.03^{i}	3.65±0.03^{b}	31.77±0.41^{a}	16.75±1.50^{f}	2.47±1.07^{a}
A. pintoi	30.66±0.07^{e}	3.02±0.01^{f}	19.92±0.16^{bc}	21.85±0.76^{de}	0.91±0.39^{a}
PCF	88.50	7.50	17.00	14.40	2.20

PCF = Pelleted commercial feed, CP = Crude protein, CF = Crude fibre and EE = Ether extract
All means significantly different ($p<0.05$) except for EE

Based on National Research Council (NRC), adult rabbits require about 12% of crude protein, 14% of crude fiber and 2% of crude fat daily (Cheeke, 1986). Protein is important as it is a fundamental component of animal tissue and helps in development of muscles, cell tissue, certain hormones and all enzymes (Szendrő et al, 2011). The previous research concluded that increasing protein level in the rabbit diets helped to improve productive efficiency (Thu and Dong, 2008). As rabbits are coprophages in which the feed consumed is processed twice, they ingest feed during the day and produce and consume soft faecal pellets at night. Therefore, an increase in the crude protein content of a feedstuff will increase its faecal crude protein digestibility. The structure of proteins of feedstuffs with high crude protein content such as legumes is generally less resistant to digestion. From the results, all 10 legume species had high protein content and meet or in excess of the daily crude protein requirement of rabbits ($P<0.05$). This means that all 10 legumes can be fed to rabbits as protein sources. However, when formulating the legume based diet for rabbit, the percentage of other nutrients must also be taken into account.

Other than crude protein, crude fiber is also important in rabbits' diet. Low-fibre diets can result in gut hypomotility, reduced caecotrophe formation, and prolonged retention time in the hindgut. However, diets that are too high in fibre, in combination with feed restriction, can lead to an energy deficiency (Amy, 2010). Based on the proximate analysis results, *Indigofera zollingeriana* had the closest value to the daily crude fibre content required by rabbits ($P<0.05$). Other legumes contained high crude fiber, so if fed to rabbits, they should be formulated with other forages to balance the crude fibre content.

Besides that, rabbit feed should include crude fat as energy source. Healthy rabbits will consume sufficient amounts of feed to meet their digestible energy (DE) requirements. Rabbits will consume more feed if they are fed a low energy diet, and will consume less feed if they are fed a high energy diet (Amy, 2010). Therefore, legumes with low crude fat content will be useful if low fat diet is required.

The mean consumption of each legume by rabbits from the 1-bowl test is shown in Figure 1. The result showed significant difference ($P<0.05$) between all 10 legume species. Iyeghe-erakpotobor and Muhammad (2008) reported that all legumes were consumed in medium amounts when fed as the sole forage source, all are potentially suitable for feeding to rabbits. However, when legumes were fed in combination with grasses, intakes were quite variable. There was no consistency in intake for any particular legume in mixture with various grasses or for a particular grass in combination with various legumes.

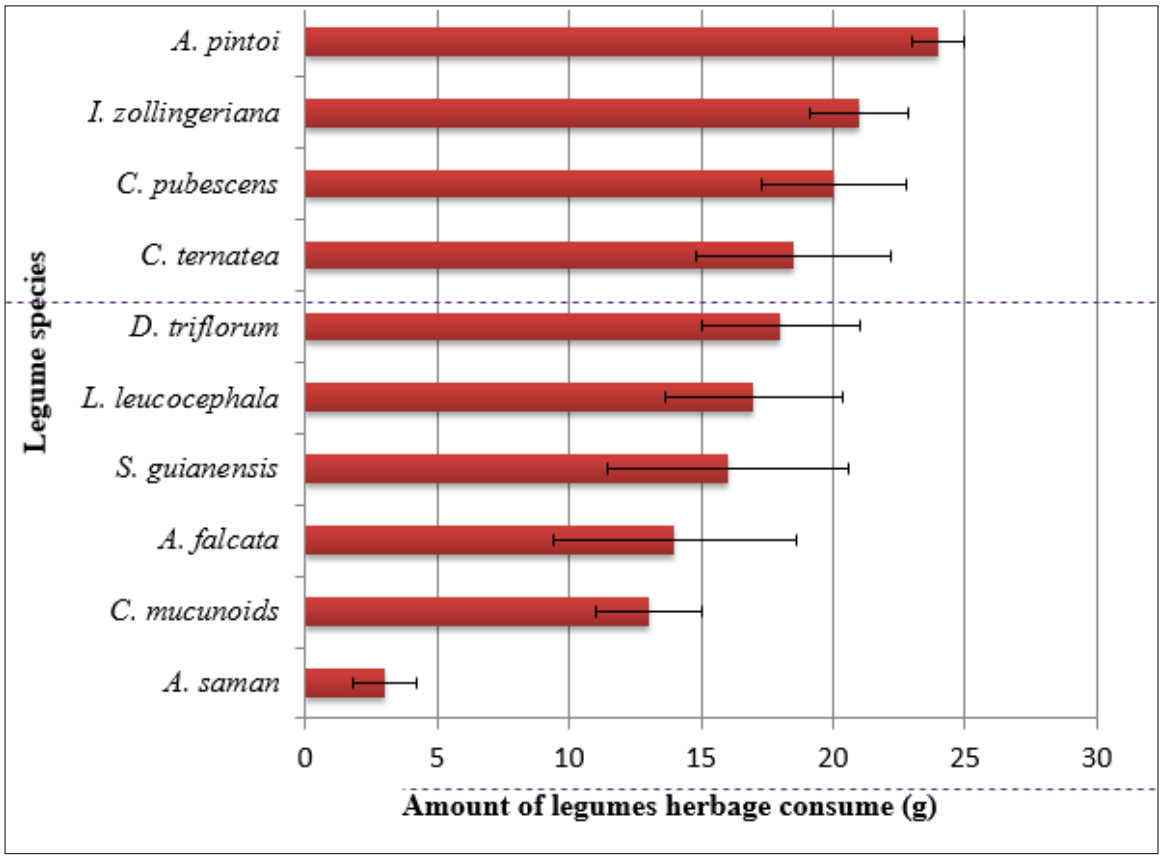

Figure 1: The amount of legume herbages consumed by rabbits in palatability test (single bowl test)

Rabbits are very selective in their feeding behavior and in the wild will nibble and select specific plant parts. They generally select leaves rather than stems, young plant materials rather than old and green rather than dry materials, resulting in a diet that is higher in protein and digestible energy and lower in fiber than the available total plant material (Safwat et al., 2014).

In double bowl test, the mean consumption of each legume by the rabbits is shown in Figure 2. There were significant differences ($P<0.05$) among all 10 legume species (Figure 2). Based on both single and double bowl tests, the results showed that *Arachis pintoi*, *Centrosema pubescens* and *Indigofera zollingeriana* were the legumes most preferred and *Albizia saman* was the least preferred by rabbits. The acceptance of the legumes under test was determined as average consumption for the test period (Aldrich and Koppel, 2015). From the single bowl test carried out on the rabbits, *Arachis pintoi* was consumed in the highest amount compared to other legumes which implied that the acceptance and palatability of *Arachis pintoi* in rabbit's diet was good.

Figure 2: The preference of legume herbages by rabbits (left is the most preferred herbage)

Meanwhile, the preference of the legumes was calculated based on the difference of total weight of two legume samples given on offer and left as orts and observation on the first approach to one of the food out of two foods served (Aldrich and Koppel, 2015). Based on the double bowl test, the amount *of Arachis pintoi* left was the least compared to other legumes, which meant that higher amount of *Arachis pintoi* was consumed by rabbits, followed by *Centrosema pubescens* and *Indigofera zollingeriana.*

There are many factors that may influence the acceptability and preference of legumes, such as olfactory appeal or freshness of the legumes, taste, size and texture of the legumes which include crunchiness, chewiness and mouth feel, nature of the ingredients in legumes. Besides that, some of the legumes may contain anti nutritional factors such as toxic amino acids or alkaloids. As an example, *Leucaena leucocephala* which is a palatable legume to rabbits; but contains the toxic amino acid mimosine which can cause poor daily weight gain and feed intake. Safwat et al. (2014) observed that the results obtained from the two trials were almost similar where *B. alicastrum* and *L. leucocephala* were the forage plants most preferred by rabbits, and then *P. oleracea* and *M. oleifera* had a moderate preference level, meanwhile; *G. ulmifolia* was the least preferred one. In accordance with the present results, Nieves et al. (2004) found that diets containing 30% or 40% *Leucaena leucocephala* leaf meal were more palatable than diets containing the same levels of *Arachis pintoi* meal. Based on palatability and selection tests, some of these legumes were consumed by rabbits in acceptable quantities, suggesting that diets based on such forages with a concentrate supplement could be used in rabbit production successfully.

Not all legumes were found to be suitable to completely replace commercial diet in rabbits, thus suggesting that legumes can be combined with other forages in rabbit's diet for successful production. Safwat et al. (2014) concluded that a range of tropical forages were eaten in acceptable quantities by rabbits, suggesting that diets based on such forages with a concentrate supplement could be used successfully for rabbit production. Nevertheless, this study was conducted over short period and longer-term studies, which examine growth performance as well, are needed before recommendations could be made on appropriate ration formulations for commercial use. The findings of Raharjo (1987) can be applied to Indonesian conditions, and probably other tropical areas, for the selection of feedstuffs which will maximize the efficiency of small scale rabbit production under village conditions.

Conclusion

All legumes tested contained nutrient composition that met or in excess of the daily nutrient requirement and the composition of pelleted commercial feed of rabbits. Among the 10 legumes, *Arachis pintoi*, *Centrosema pubescens* and *Indigofera zollingeriana* are the legumes most preferred and *Albizia saman* was the least preferred by rabbits.

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