Agronomic Properties of Aleman Grass *(Echinochloa polystachya*), Para Grass (*Brachiaria mutica*), Setaria Grass (*Setaria splendida)* Mixtures and Their Palatability in Sheep

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Abstract

A study was conducted to evaluate the agronomic properties of Aleman grass (*Echinochloa polystachya*), Para grass (*Brachiaria mutica*) and Setaria grass (*Setaria splendida)* mixture and its palatability in sheep. The objectives of the study were to evaluate the agronomic properties in mix planting of Aleman grass, Para grass, and Setaria grass and to evaluate the palatability of their mixture by sheep. The grass was planted in monocrop, two grass species mixture and three grass species mixture in a research area, Department of Animal Science Universiti Putra Malaysia. The grass was planted for two months in a randomized complete block design and was cut about 15 cm above ground level for each grass and the data was collected weekly. Botanical composition and grass tiller count showed there was no difference ($P>0.05$) among the grass planted as single grass to the planted two and three grass species. There was a significant difference ($P<0.05$) in grass height that decreased in two and three grass mixtures. The study on palatability was conducted using single-bowl and double-bowl methods. There were significant differences ($P<0.05$) in both tests that the single grass was more palatable than the mixture of two or three grasses. The mixture of three grass takes a long time for the sheep to finish grass compared to the mixture of two and single grass species. In conclusion, this result showed that different mixtures of planting and feeding to the animal affect agronomic properties and palatability in sheep.

Keywords: Agronomic properties, Aleman grass (*Echinochloa polystachya*), Para grass (*Brachiaria mutica*) Setaria grass (*Setaria splendida)*, palatability, sheep.

Introduction

The production of animals depends on the production and the quality of the grass would be the main factor to produce optimal production, and most of the ruminant animals in Malaysia are fed on low-quality forage. Most of the forage fed to animals is low in crude protein content, low digestibility and low in palatability. This is due to improper pasture management and the high cost of purchased feed. Therefore, many studies have been conducted to select the best forage for the animals to achieve a high production level. Aleman grass (*Echinochloa polystachya*), Para grass *(Brachiaria mutica*) and Setaria grass (*Setaria splendida*) are known as forage species that grow well on moist soil. This species dominated moist pasture land and poorly drained soil and was most commonly used. However, the production of these grasses in mixtures is not known and fewer

studies have been conducted on this aspect. The selected grass for this study is also based on its strength. Therefore, this study was conducted to evaluate the agronomic properties and palatability of Aleman grass, Para grass and Setaria grass as single and mixtures in sheep.

Materials and Methods

This study was divided into two parts, i) the agronomic properties and ii) the palatability of the grass mixtures to sheep. The first part of the study was to compare the botanical composition, grass height, leaf to stem ratio, and tiller number of the grass based on the single plant and the mixture of two and three grass species. The second study evaluated the palatability of the grass mixtures by sheep.

Experimental site and design

The study was conducted at the Faculty of Agriculture, Universiti Putra Malaysia farm. The grass was planted in plots using a randomized complete block design with three replicates (Figure 1).

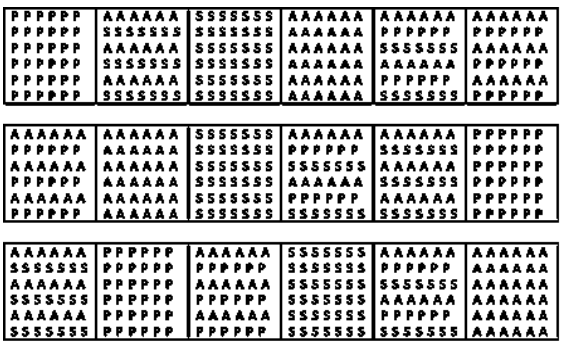

Figure 1. The layout plan of the plot using a randomized complete block design (A: Aleman grass, P: Para grass, S: Setaria grass)

Aleman grass (A), Para grass (P) and Setaria grass (S) plot was established using stem cutting and was planted in plot size 20 x 15 meters. The size of each treatment was 2 x 2 meters and separated by a one-meter alley. Aleman grass, Para grass and Setaria grass were planted at the plot with 0.4 meter distance per grass. The grass was allowed to establish for 1 month before data is collected.

Data and sample collection of grass

After establishment, the grass was cut 15 cm above the ground. The botanical composition was determined using the quadrat sampling method to measure the grass and weed per unit area. The height of the grass was measured and recorded on weekly basis until the 4th week, from the ground level to the highest leaf. The botanical composition, tiller number, and leaf to stem ratio were measured in the 4th week. The tiller number was determined by calculating the number of tillers produced after the first cut of the grass and the leaf to stem ratio calculated during harvest. The dry matter yield (t/ha) was calculated based on the dry matter yield from the plot.

Palatability Test

The palatability test was conducted using single and double-bowl methods. The single bowl method determined the time taken for each sheep to finish the given grass mixtures, and the double bowl method ranked the grass mixtures according to palatability and preference by sheep.

Single bowl test

The test was set up to test the palatability of the grasses (single or mixtures) involving six sheep (age 12 months). The sheep were kept in individual pens. Approximately 300 g of Aleman grass, Para grass, Setaria grass, Aleman grass mixed with Para grass, Aleman mixed with Setaria grass, and Aleman grass mixed with Para grass and Setaria grass was offered to each sheep. For the next day, the

test was changed to the next treatment until all sheep were tested. Time was recorded from exposure to the grass until finished the grass.

Double bowl test

The test was based on the observation of preferred grass to be consumed by sheep. Grasses (single and mixtures) were put in ranks in the same area. The ranking was determined by observing the grass that the sheep consumed first followed by the next grasses (single or mixtures). The sheep were allowed to sense the grasses first before the test started.

Data analysis

The data of agronomic properties such as botanical composition, tiller number, leaf to stem ratio, DM yield and palatability were analyzed by one-way ANOVA method using SAS. The significance between means was identified using Duncan's multiple range test. The mean difference was considered significant at ($P<0.05$).

Results and Discussion

Agronomic properties

The percentage of grass and weeds growing in the plot planted either with single grass (Aleman, Para, Setaria) or mixtures (Aleman+Para, Aleman+Setaria or Aleman+Para+Setaria) was presented in Figure 2.

The botanical composition in terms of the percentage of grass and weed in each plot was no significant differences ($P>0.05$). It ranges between 64.3 – 68.7 (%) for the grass and 31.3 – 35.7 (%) for the weed. These parameters were measures to indicate the persistent growth, which is an important factor in the agronomic productivity of a grass species. The botanical composition of some of the plots may be varied throughout the growing season. This may be to the different relationships between the individual grasses and the invading species and it also uses to estimate the production of forage (Guo *et al.*, 2007).

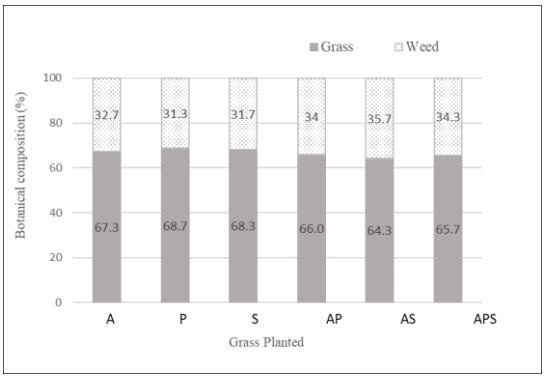

Figure 2. The percentage of grass and weeds growing in the plot planted either with single grass or mixtures (A: Aleman grass, P: Para grass, S: Setaria grass).

There was no significant difference ($P>0.05$) in the tiller numbers of Aleman grass, Para grass and Setaria grass. The average tiller number produced by the grasses is presented in Table 1.

Table 1. Number of tillers and leaf: stem ratio of the grass planted as a single, mixture of two or three species of grass per plot

Grass planted (single or mixed)	No of tiller	Leaf: stem ratio
Aleman	3.0±0.36	1.5:1.0
Para	2.9±0.60	1.7:1.0
Setaria	3.1±0.40	1.7:1.0
Aleman + Para	3.0±0.07	1.8:1.0
Aleman + Setaria	2.1±0.15	1.5:1.0
Aleman + Para + Setaria	2.9±0.36	1.5:1.0

The number of tillers has no significant difference may be due to the short period of

studies, and according to Glover *et al.* (2004), once the seeded species continued to grow, their proportion by tiller count increased and therefore their botanical composition also increased.

The total number of tillers produced is related to the adaptation of this species to the soil and climatic conditions in the study area. The formation, development, growth and senescence of tillers are influenced by climatic conditions, such as temperature, water and nutrient availability as reported by Fagundes *et al.* (2006). The number of tillers does not correspond with an increment in biomass, this is possibly due to the morphological characteristics of the tillers. There is evidence that some plants have a smaller number of live leaves per tiller, a smaller final length of the leaf blade and a slower leaf emergence rate presented. The plants have specific mechanisms for limiting the breathable area especially to cope with the worse water deficiency (Fagundes *et al.,* 2006) and include inhibiting the tillering and branching, the anticipation of established tiller death, reduction of the leaf area accelerating the senescence of older leaves, and the further growth of the root system (Morales *et al.,* 1997). In maintaining the development of tillers, Nabinger and Pontes (2001) suggested that the plants may initially compromise tillers, rather than reducing the size and lifespan of leaves. Understanding the density behaviour of living and dead tillers can be an important strategy for the management of pasture because the density of tillers determines the durability of the pasture (Lemaire and Chapman 1996).

Leaf to stem ratio

There was no significant difference (P>0.05) for the leaf to stem ratio show of grass planted either single or mixture (Table 1). The percentage of ranges between 59.7 to 64.1 and 39.4 to 40.4 for leaves and stems, respectively for all plots (Figure 3)

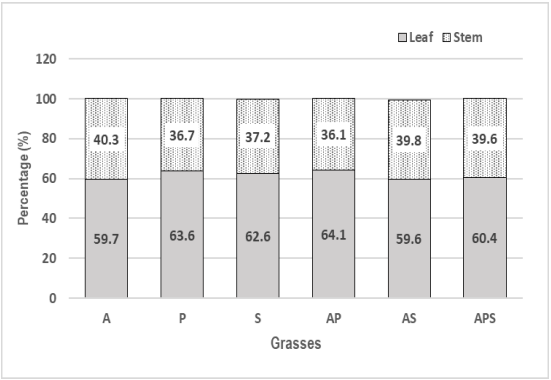

Figure 3. The percentage of leaf and stem of the grass planted either with single grass or mixtures (A: Aleman grass, P: Para grass, S: Setaria grass)

Leaf to stem ratio was the most important structural characteristic of pasture land. A critical threshold for the leaf to stem ratio has been considered to be above 50% of leaf, with a value lower than this, which will cause a fall in the quantity and quality of the forage produced (Pinto *et al.,* 1994). While some cultivars that had values below or near 50% leaf values may cause by variations in temperature or received low water supply that led to lower stem elongation and leaf length. In this study, the percentage of leaves is above 50%, which indicates that the grass planted either as a single or mixture is suitable as animal feed. This suggests a likelihood of good quality and intake characteristics since leaves generally have greater digestibility, intake and crude protein contents than stems (Hides *et al.,* 1983).

Plant height

Aleman, Para and Setaria grasses

The height of Aleman, Para and Setaria grasses planted single, the mixture of two and three is presented in Figures 4a, b, c. The

height of all grasses in the first week showed no significant difference (P>0.05) when planted as a single (41 cm, 44 cm, 39 cm), mixtures of two (40 cm, 43 cm, 39 cm) and three types of grass (39 cm, 43 cm, 38 cm) for Aleman, Para and Setaria grasses, respectively.

In week 2 (76 cm), week 3 (118 cm) and week 4 (132 cm), there was a significant difference (P<0.05) in height of Aleman grass compared to Aleman grass planted in mixtures two and three grass. The mixture of Aleman grass with Para grass at week 2, week 3 and week 4 were 73.5 cm, 115.5 cm, and 125 cm, respectively. The lowers height shown in the mixture of Aleman grass with Para grass and Setaria grass was 70 cm, 112 cm and 120 cm at week 2, week 3 and week 4, respectively.

There was a significant difference (P<0.05) in the height of single planted Para grass and the mixture of two and three grasses on week 2, week 3 and week 4. The height single planted of Para grass was 84 cm, 128 cm, and 145 cm for week 2, week 3 and week 4, respectively. The Para grass mixture with Aleman grass was 80 cm, 125 cm, and 135 cm for week 2, week 3 and week 4, respectively. The height of Para grass mixed with Aleman grass and Setaria grass was lower, 78 cm, 123 cm, and 129 cm for week 2, week 3 and week 4, respectively.

The height of Setaria grass in the first week showed no significant difference (P>0.05) with 39 cm, 39 cm and 38 cm for a single, mixture of two and three grasses planted, respectively. There was a significant difference (P<0.05) in plant height of Setaria grass planted in a single, mixture of two and three grasses in week 2 (71 cm), week 3 (101 cm) and week 4 (126 cm). The Setaria grass mixed with Aleman grass was 70 cm, 95 cm and 118 cm for week 2, week 3 and week 4, respectively. The plant height of Setaria grass mixed with Aleman grass and Para grass was lower, 67 cm, 90 cm and 108 cm for week 2, week 3 and week 4, respectively. Glover (2004) reported that the height of mixed grass is less compared to single grass because they need to compete with each other.

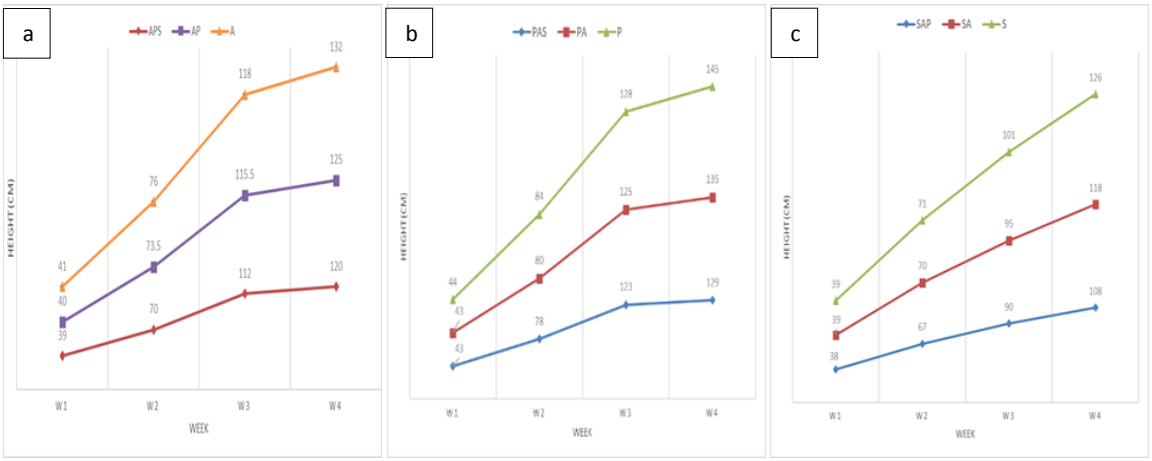

Figure 4. Plant height by weeks of a) Aleman (A), b) Para (P) and c) Setaria (S) grass planted as a single, mixture of two or three species of grass per plot.

Dry Matter yield

There was no significant difference (P>0.05) in DM yield (t/ha) for all treatments (Table 2). Even though it is not significantly different, the result showed that the DM yield was higher in Para grass as a single resulting in higher compared to others. Aleman grass as single yields the lowest dry matter.

Table 2. Dry matter (DM) yield of grass planted in a single, mixture of two or three species of grass

Grasses	Dry Matter yield (t/ha)
Aleman Grass (A)	1.73 ± 0.02
Para Grass (P)	2.37 ± 0.03
Setaria Grass (S)	1.99 ± 0.02
Aleman + Para (AP)	2.18 ± 0.03
Aleman + Setaria (AS)	1.83 ± 0.01
Aleman + Para + Setaria (APS)	2.01 ± 0.02

Dry matter (DM) yield is a measurement of the amount of a crop harvested per unit of land area and it is related to the production of leaf to stem ratio and the tiller population density in the area (Brâncio *et al.,* 2003). The finding from this study was similar to the study reported by Ali *et al.* (2013) for *S. splendida* and *S. splendida*/C. *pubescens* planted as single or mixed cropping in peatland. Wang *et al.* (2003), suggested that it is important to estimate the forage quality not just based on the yield, the knowledge of the chemical composition equally important.

Palatability test

The grass palatability was tested in sheep using a single bowl and double bowl test. The single bowl result was based on the time measured the sheep finish eating the forages. The double bowl result is based on observation and determination of the ranking of the grass that sheep prefer to consume.

Single bowl

The mean time spent by sheep in a single bowl palatability test was presented in Figure 5. There was a significant difference (P<0.05) between single grass and mixed grass. The least time spent by sheep in the palatability test was 17.04 minutes, 18.33 minutes and 20.41 minutes for Para, Setaria and Aleman grass, respectively. The longest time spent finishing the grass was a mixture of Aleman, Para and Setaria grass (26.84 minutes). The sheep had taken 26.24 minutes to finish the mixture of Aleman and Para grass and 25.44 minutes to finish the mixture of Aleman grass and Setaria grass. Overall, the sheep spent the least time with single grass followed by a mixture of two and three grasses.

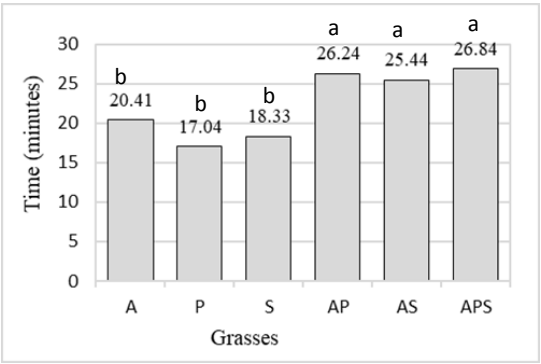

Figure 5. Time spent by sheep in single bowl palatability test of the grass offered in a single, mixture of two or three species of grass. (A: Aleman grass, P: Para grass, S: Setaria grass

Based on the palatability result, a single grass is considered more palatable than a mixture of grass, where the sheep tend to spend shorter times as the choices of grasses are not available. The work of Smith *et al.* (1984) demonstrated that measuring consumption continuously in

one and two-bowl tests could demonstrate adaptation and vigour of meal consumption, but did not reveal the individual animal preferences.

Double bowl

The grasses rank in descending order in terms of preference by sheep with Aleman grass followed by Para grass, Setaria grass, the mixture of Aleman grass and Para grass, the mixture of Aleman grass and Setaria grass, and the last mixture of Aleman grass, Para grass, and Setaria grass. The result showed that single grass was the most palatable grass, mixed of two grass was medium palatability, and mixed of three grass has low palatability. Based on data from the palatability test, there was a significant relationship between feed preference and time spent in sheep. The single grass is more palatable than the mixed grasses (Figure 6).

Figure 6. The preference of grass by sheep in double bowl palatability test of the grass offered in a single, mixture of two or three species of grass (A: Aleman grass, P: Para grass, S: Setaria grass).

Factors that may contribute to the preference of feed by sheep were the texture, smell, feel, leafiness, and moisture content. High quality forages are generally high palatability. A study by Morand-Fehr (2003) showed that sheep can taste a feed of bad palatability again after having it and immediately stop eating or refusing it. Sheep seem to have a good memory for taste. Some studies proposed alternative techniques to be used instead of single-bowl or two-bowl methods to determine palatability. These more conditioned response-type studies using operant testing can provide some limited value to our understanding of preference. However, they can be very time consuming, and rely on very specialized facilities, trained animals and technicians. These tests can be directional, but remove the influence of the animal's surroundings and the human-owner factor.

Conclusion

The agronomic properties, the botanical composition, tiller number and leaf to stem ratio were similar for both single and mixed planted grass including the DM yields. Using single and double bowl techniques not be able to conclude the palatability of grass by sheep, since they spend more select the grass before finishing it.

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