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# EXPLORING THE POTENTIAL OF *PANICUM SARMENTOSUM* FOR USE AS A FORAGE GRASS BASED ON ITS NUTRITIVE PROPERTIES

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## Abstract

The study was conducted to explore the acceptability of *Panicum sarmentosum* herbages for ruminant feed. Its acceptability was evaluated by comparison of some chemical attributes of the herbage to those of *Panicum maximum.* These two grasses were grown in plots, 15 $m^2$ each, under farmer coconut plantation at Lalombi village, Donggala Regency, in 2009. The plots were arranged by complete block design, represent 2 grass species with 10 replications, resulting 20 plots. Herbage samples were collected from the grasses of 42 days regrowth for lab analysis. Proximate analysis was applied to determine the crude-protein, crude-fiber, ether-extract, and ash contents; 'atomic absorption spectrophotometry' was used to determine the Ca, K, Mg, Na, Cu, Fe, Mn, and Zn, and 'auto analyzer' was used to determine P content. Data were analyzed by ANOVA using a statistical package. The results of this study have shown that both species possess very similar in compared nutrient contents, *i.e.*: crude-protein, crude-fiber, crude-fat/ether-extract, ash and nitrogen-free-extract, macro-minerals (Ca, K, Mg, Na, and P), and micro-minerals (Cu, Fe, Mn, and Zn). It can be concluded that *P. Sarmentosum* would be equally accepted for use as a forage crop.

***Key words*** **:** forage crops, herbage, nutrient contents, macro- and micro-minerals.

## Introduction

Grasses are the dominant source of animal feed in the tropics, especially in the developing countries, such as Indonesia. One of the most important sources of grass species is *Panicum*. *Panicum* is a large genus of the grass family (*Poaceae*), consisting of hundreds of grass species native throughout the tropics with only a few species that can extend into the warmer regions (Aliscioni *et al.,* 2003; Wouw *et al.,* 2008). The diversity of this genus is an opportunity to find new genotypes to be used as forage crops. There are currently limited species of this genus that have been used and cultivated as forage grasses, for instance *Panicum antidotale, P. coloratum*, *P.maximum*, and *P. repens*. Among these species, *Panicum maximum* is one of the more well known, widely used, studied and published forage grasses.

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*Panicum maximum* (guinea grass) is a long live (perennial), an African origin species that were introduced to almost all tropical regions for use as forage source. Depending on the growth environment, particularly rainfall and soil fertility, and management practices, herbage yields and nutritive value vary widely. Work on nine *P. maximum* ecotypes, Adjolohoun, *et al.* (2013) found significant differences for dry-matter and crude-protein between ecotypes. Intercropping *P. maximum* with either herbaceous, shrub or tree legumes increased herbage biomass and nutritive value of the grass (Odedire and Babayemi, 2008; Ajayi, *et al*. 2009; Alalade, *et al*. 2014). Alalade *et al.* (2014) study has confirmed that increase in biomass yield, number of tillers, tiller height, leaf length and leaf width, the crude protein, and gross energy content of the grass inter planted with the *Stylosanthes* were higher than those from other legumes (*Cajanus cajan*, or *Canavalia ensiformis*). Intercropping *P. maximum* with either herbaceous forage legumes of *Lablab purpureus*, *Centrosema pubescens*, *Stylosanthes guianensis*, or *Aeschynomene histrix* increased Ca, P, Na and Fe contents of the herbage produced by the grass (Ajayi, *et al.* 2009). Amar (2004) has published that yield, nitrogen content, and herbage digestibility of guinea grass were higher from plants grown under tree legume canopy of *Albizia lebbeck* compared to those from the open between the tree canopies. In production systems, Ojo *et al*. (2013) maintained that intecropping *P. maximum* and *Lablab purpureus* can be grazed by ruminants or harvested to support livestock productivity, or can be conserved to be used when feed availability and quality are extremely low. *P. maximum* is a major feed of grazing animals in South Western Nigeria (Sodeinde, *et al*. 2009); and this grass species had long been introduced to many countries for forage uses, such as in Nepal since 1801-1802 (Wisumperuma, 2007), and to Australia in the early 1900's (Sugar Research Australia, 2013). These are examples of publications that prove the popularity of the forage grass *Panicum maximum* (guinea grass).

Unlike *P. maximum*, information on *P. sarmentosum* Roxb., especially for its use as forage is very limited. An early publication on *Panicum sarmentosum* by Watson and Dallwitz (1992) only consider it as a weed. Clayton, *et al.* (2008) explained the description of this grass and its distribution. Nevertheless, a study on growth and herbage production of *Panicum sarmentosum* as forage has been reported (Tarsono, *et al.* 2009). Tarsono, *et al.* (2009) has found that *P. sarmentosum* is better than the *P. maximum* in terms of number of tillers and herbage yields. This grass has also been used as forage for 'cut and carry practices' in Central Sulawesi.

The aim of this study is to fill the lack of knowledge of the new promising forage grass. Specifically, this study seeks to explore the chemical attributes of the herbage of *P. sarmentosum* to indicate its nutritive value for acceptability for use as a forage crop in comparison to the well-known grass of *P. maximum*.

## Materials and Methods

This study is a continuation of the early growth of *Panicum sarmentosum* Roxb. grown on a farmer's coconut plantation (Tarsono *et al*. 2009). Five years after the early growth study, the grass has been distributed and used by some farmers, and then its herbage chemical composition and some macro- and micro-minerals are compared to the well-known and widely used forage grass *P. maximum*.

### Study site

The experimental plots were originally set up in 2009 (Tarsono *et al*. 2009) on a farmer coconut plantation, at Lalombi village, Sub District South Banawa (Kecamatan Banawa Selatan), Donggala Regency, Central Sulawesi Province, Indonesia. South Banawa is situated on 0p 45'53" – 1p 00'57"S and 119p 32'30 – 119p 46'36"E (Figure 1). Lalombi village is located approximately 67 km south of Palu, the capital city of Central Sulawesi.

Soil texture at the experimental plot was silty-loam (sand, silt, and clay contents were 36%, 57%, and 7%, respectively), with a pH of 5.6, contained organic carbon (3.9%; Wakley & Black), nitrogen (0.3%), extractable phosphorus (15 ppm, Olsen), potassium (0.9 cmol/kg), sodium (0.4 cmol/kg), magnesium (0.1), and calcium (4.0). The soil has a high cation exchange capacity (CEC) of 41.6.

### Experimental design and herbage samples

The present study modified the study design of Tarsono *et al*. (2009) and compare only the two grasses, *P. sarmentosum* and *P. maximum* with 10 replications, resulting in 20 plots of 15 $m^2$ (3 m x 5 m) each. *P. sarmentosum* and *P. maximum* were equally planted on 10 plots independently, that were arranged in a complete block design. Each of the 2 grasses was grown in 3 rows of 1 m apart, and 75 cm plant distances in each row, resulting 21 clumps/plot (3 rows x 7 clumps/row).

For the need of chemical analyses, herbage sample was taken, at 42 days after the previous harvest (42 days of regrowth), from the harvesting of the clump at the

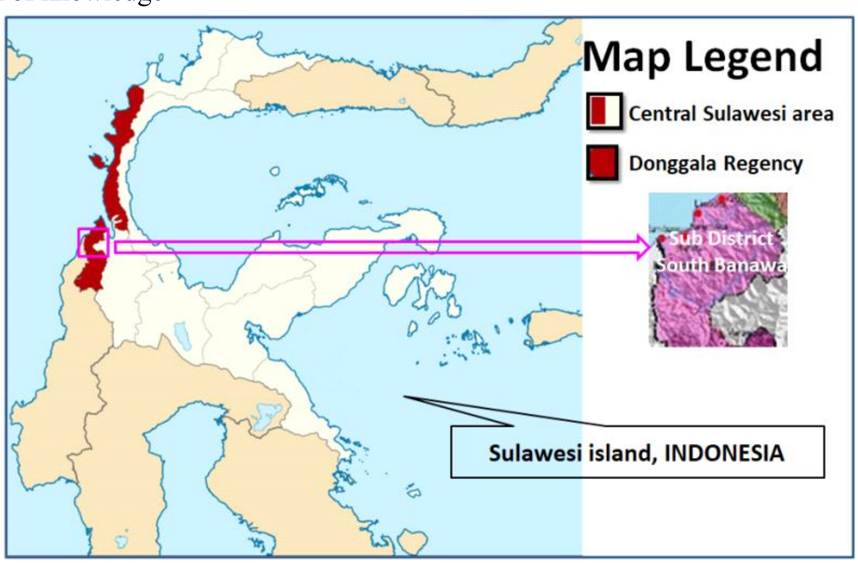


**Fig. 1:** Location of experimental plots was in Donggala Regency, Indonesia.

ground surface at the center of each experimental unit, 10 samples for each of the studied *Panicum* grasses. Each of the samples was dried in a forced-draught oven at 65°C for 3 days, then they were independently ground to pass 2 mm sieve for laboratory analyses.

**Plant attributes and statistical analysis**

Each of the herbage samples was prepared for proximate analysis by Kjeldahl digestion using a block digester, then analysed for the respective proximate compositions of the main nutrients according to the official methods of analyses (AOAC, 1995). This proximate analysis was applied to determine the crude-protein, crude-fiber, crude-fat (*ether extract*), ash, and calculate the *nitrogen-free extract*. For mineral analysis, samples were prepared by the wet digestion method using concentrated sulphuric acid with the presence of hydrogen peroxide, but Kjeldahl digestion was used for phosphorus (P) determination. The content of calcium (Ca), potassium (K), magnesium (Mg), sodium (Na), copper (Cu), iron (Fe), manganese (Mn), and zinc (Zn) were determined by atomic absorption spectrophotometry (AAS) method, and P was determined by the auto analyser (AA) method (Perkins, 1982; AOAC., 1995). Each of the samples was analysed in duplicates at the Feed Nutrition Laboratory of the Faculty of Animal Husbandry and Fishery, Tadulako University.

Analysis of variance (ANOVA), using *Statistix 4.1 software*, was used to determine the effect of grass species on each of the considered nutritive properties. A nutritive value that found to be significantly influenced by the grass species, is further analysed by '*the least significant differences*' method (LSD, at P=0.05).

## Results and Discussion

**Level of nutrient contents comparison based on proximate analysis**

The two grasses have no significant differences in any of nutritive properties, *i.e.* crude-protein (CP), crude-fiber (CF), crude-fat/ether-extract (EE), ash, and Nitrogen-free Extract (Table 1). Crude-fiber and nitrogen-free-extract were the only two nutrients that have differed more than 1% between the grasses, *P. sarmentosum* has 1.61% higher in CF than *P. maximum*, but 1.65% lower NFE. The other three nutrients, the grasses has only differed 0.21%, 0.35% and 0.10% respectively for crude-protein, ether-extract, and ash. The similarity in nutrient content suggests the acceptability of *P. sarmentosum* for use as a forage grass as like as *P. maximum*.

In the crude-protein content, for instance, both species have relatively high contents, 9.77% and 9.98%, that is similar to most forage grasses. Many studies on *P. maximum* on different environmental conditions, and various in management and farming practices have shown crude-protein content range between as low as 4.50% to 10.89% (Amar, 2004; Odedire and Babayemi 2008; Bamikole and Ikhatua, 2010; Alalade *et al.* 2014; and Gracindo *et al.* 2014). Compared to the dry herbage of guinea grass (11.2% CP; 33.6% CF; 1.8% EE, and 40.9% NFE) reported by Aregheore (2001), this present study has revealed reasonable nutrient contents of the 2 *Panicum* species. Although, *P. sarmentosum* and *P. maximum* contained crude-fibers, respectively 39.49% and 37.88% table 1, higher than 33.6% in *P. maximum* reported by Aregheore (2001). This difference may responsible of many affecting factors, particularly plant age/cutting intervals. Forage quality decreased as length of cutting interval (plant age/regrowth) increased, in terms of decreasing in crude protein and increasing in crude fiber, mainly cell wall concentrations (Man and Wiktorsson, 2003; Lounglawan, *et al.*, 2014; Hutasoit, *et al*. 2016). Rusdy (2014) found that both crude protein concentration and dry-matter digestibility of *P. maximum* constantly decreased along with an increase in length of cutting intervals, 30, 45 and 90 days.

This presented study has suggested comparable ash contents, in both *P. sarmentosum* (12.52%) and *P. maximum* (12.62%) in this study with 12.00% of *P. maximum* herbage reported by Odedire and Babayemi (2008). Studied on biomass production and nutritive value of nine *Panicum maximum* ecotypes in the Central region of Benin (West Africa), Adjolohoun *et al*. (2013) found 8.25% mean the ash content of the herbage (ranged 5.77–15.99%, on dry-matter basis). Ash contents of the two *Panicum* grasses of this present study fell in the range of the value indicated by other studies. Likewise, fat (ether extracts) contents of *P. sarmentosum* and *P. maximum*, 2.78% and 2.43%, respectively fall in the median values of other studies. For instance, Aregheore, (2001) has reported a lower fat content 1.8% in herbage of *P. maximum* in Samoa, while other revealed a mean fat concentration 7.0% of the same grass species (Odedire and Babayemi, 2008). The dissimilarity among studies is a result of many factors influencing plant performances at different growth environments.

In addition, the two studied *Panicum* species have also indicated similarity in nitrogen-free extract (Table 1), which slightly lower (35.44% and 37.09) than 40.90% in *P. maximum* (Aregheore, 2001). There are many factors might contribute this variation, such as, soil fertility or fertilizer application, and/or plant age or harvesting

**Table 1:** *P. sarmentosum* and *P. maximum* are compared in their CP, CF, EE, Ash, and NFE concentrations, at 42 days regrowth.

| Attributes (% on DM bases) | *P. sarmentosum* | *P. maximum* |
|---|---|---|
| Crude-protein (CP) | 9.77[a] | 9.98[a] |
| Crude-fat/ether-extract (EE) | 2.78[a] | 2.43[a] |
| Crude-fiber (CF) | 39.49[a] | 37.88[a] |
| Ash | 12.52[a] | 12.62[a] |
| Nitrogen-free Extract (NFE) | 35.44[a] | 37.09[a] |

Means in the same row for each attribute with different superscripts are significantly different ($P<0.05$).

intervals (Dugmore, 2011). Findlay (2010) found that application of nitrogen fertilizer considerably increased the concentration of non-protein nitrogen (NPN) in perennial ryegrass herbage. With respect to the role of NPN in ruminant diets, this may suggest for further study on *P. sarmentosum*, the new promising forage grass.

**Macro-mineral concentrations of the compared species**

All 5 macro-minerals, Ca, P, Mg, Na, and K were comparable table 2 between the two grass species. This can also be interpreted that the grasses would have been similarly acceptable as herbage sources for ruminants. Calsium (Ca) was the only macro-mineral that exceeds the requirement of ruminants, while sodium (Na) was within the recommended level. Ca concentrations of these two *Panicum* grasses in the present study were consistently higher than those were found by many other studies, such as; guinea grass (*P. maximum*) 0.03% (Aregheore 2001), in various grazing lands in Pakistan, 0.39 – 0.74% (Khan *et al*. 2006; Khan *et al*. 2007), and in various intercropped with legumes 0.14-0.27% (Alalade *et al*. 2014). The other 3 macro-minerals have very low concentrations in the herbage dry-matter of the studied grasses, and therefore could not satisfy the need of ruminants in general, and lower than those were reported by Aregheore (2001), and Alalade *et al*. (2014).

These two *Panicum* species showed lower Mg and K compared to 0.24 – 0.29% and 1.34% of Mg and K respectively in herbage of *P. maximum* (Khan *et al.,* 2006; Bamikole and Ikhatua, 2010). Finding of low content in most macro-minerals (below the critical level of ruminant requirements) are, however, not surprising. These results were very similar to 5 macro-minerals found by Adjolohoun *et al.* (2013) from nine *P. maximum* ecotypes in the Central region of Benin. In addition, *P. maximum* is widely known and used as forage in many farming systems.

Discrepancy in macro-mineral concentration among the studies above is the responsibility of many factors, particularly stage of plant growth (plant maturity), soil mineral contents and their availabilities to the studied plants rather than the genotype of *P. maximum* used in each of the studies. McDowell and Valle (2000) maintained that mineral concentrations in forage vary considerably across the earth region as they are affected by numerous factors, including forage species, plant maturity, management of forage used, *i.e.* grazing or forage removal by haying, fertilizer application, soil type and fertility, and environmental conditions. This has been proven by many publications. Nevertheless, this present study has indicated that shortage macro minerals, except Ca, should be anticipated in the use of these *Panicum* grasses as forage sources for ruminants.

**Micro-mineral concentrations of the compared species**

The 2 *Panicum* grasses also have similar micro-mineral (copper, manganese, iron, and zinc) concentrations (Table 3). These results have shown that both *P. sarmentosum* and *P. maximum* contained high concentrations of these micro-minerals. Unlike macro-minerals, both *P. sarmentosum* and *P. maximum* were highly acceptable to ruminant feed based on the concentrations of the micro-mineral in the produced herbage.

High copper concentrations and satisfy the requirement for ruminants deviates with the common trends in the tropics, where in most cases this mineral is limited. Khan *et al.* (2006) reported high, dry basis concentrations of iron (534 ppm Fe), and zinc (31.9 ppm Zn), but low copper (6.8 ppm Cu) of forage in various grazing area in Pakistan. Similarly, Alalade *et al.* (2014), studied *P. maximum* in various intercropping of different legumes, found that dry herbage of the guinea grass contained very high concentrations of iron (242.3 – 265.0 ppm Fe), and Zinc (284.0 – 319.0 ppm Zn); but low in copper (6.71 – 6.93 ppm Cu). In addition, Aregheore (2001) used forage of guinea grass that fulfill the general requirement of ruminants in manganese (43.89 ppm Mn), iron (66.67 ppm Fe), and zinc (25.68 ppm Zn), but has the copper concentration below the required level (6.43 ppm Cu). Applied a range of Mn fertilizer levels (0 – 120 $mg/dm^3$), Flores *et al.* (2017) found manganese concentrations in the aerial part of *P. maximum* reached 188.25 – 228.75 ppm, and 283.25 – 522.00 ppm Mn from the first and second cuts, with the fertilizer applications. This study has clearly indicated that both *P. sarmentosum* and *P. maximum* could satisfy the required levels of the four micro-minerals by ruminants, which has different from other studies in the case of the copper mineral.

**Table 2:** *P. sarmentosum* and *P. maximum* are compared in their Ca, P, Mg, Na, and K concentrations, at 42 days regrowth.

| Attributes (% on DM basis) | *P. sarmentosum* | *P. maximum* | Base on beef cattle requirements* | |
|---|---|---|---|---|
| | | | Requirements | Max. Tolerable |
| Calcium (Ca) | 1.01[a] | 1.13[a] | 0.18 – 0.31 | 1.80 |
| Phosphorus (P) | 0.04[a] | 0.03[a] | 0.18 – 0.27 | 0.30 |
| Magnesium (Mg) | 0.03[a] | 0.03[a] | 0.10 – 0.20 | 0.40 |
| Potassium (K) | 0.15[a] | 0.16[a] | 0.60 – 0.70 | 3.00 |
| Sodium (Na) | 0.06[a] | 0.08[a] | 0.07 – 0.10 | 4.00 |

Means in the same row for each attribute with different superscripts are significantly different ($P<0.05$)*Range values based on various stages of production, and body weight (NRC., 2000; Beef Cattle Nutrition Series. 2018).

**Table 3:** *P. sarmentosum* and *P. maximum* are compared in their Cu, Mn, Fe, and Zn concentrations, at 42 days regrowth.

| Attributes (% on DM basis) | *P. sarmentosum* | *P. maximum* | Base on beef cattle requirements* | |
|---|---|---|---|---|
| | | | Requirements | Max. Tolerable |
| Copper (Cu) | 34.62[a] | 33.49[a] | 10.00 | 100.00 |
| Iron (Fe) | 256.88[a] | 260.01[a] | 50.00 | 500.00 |
| Mangaan (Mn) | 129.02[a] | 156.58[a] | 20.00 – 40.00 | 1000.00 |
| Zinc (Zn) | 38.48[a] | 39.95[a] | 30.00 | 500.00 |

Means in the same row for each attribute with different superscripts are significantly different ($P<0.05$)*Range values based on various stages of production, and body weight (NRC., 2000; Rick, et al., 2011; Beef Cattle Nutrition Series, 2018).

Most of the findings in this study have indicated a very close similarity between the two studied *Panicum* species. This similarity has suggested that base on the nutritive attributes, *P. sarmentosum* would be equally accepted as forage grass as like as *P. maximum*. Both *Panicum* grasses possessed reasonable nutrient contents by proximate analyses table 1, and all compared micro-minerals were above the critical levels of ruminants' requirement (Table 3). In addition to the nutritive consideration, Tarsono *et al.* (2009) reported that *P. sarmentosum* was better than the P. maximum in respect to the mean of the number of tillers and dry forage yields, respectively 113 vs. 99 and 330.3 kg/ha vs. 288.5 kg/ha. However, these 2 *Panicum* grasses contained mostly very low in macro-minerals, low in sodium (Na) except high in Ca (Table 2). In order to optimize livestock productivity in ruminants fed on these forage grassess, there is therefore a need to supplement with macro mineral sources.

Finally, the low nutrient and mineral concentrations of the herbage of these *Panicum* grasses can be corrected by various ways, such as; fertilizer applications, mix-planted grass-legumes, and/or feed supplements. Agronomical method, for instance, Rusdy (2014) has found an increase in crude-protein, Ca, and P contents of *P. maximum-Cenrosema pubescens* mix with the increase legume proportion in mixtures. Similarly, improvements in herbage yield and nutritional composition of *P. maximum* interplanted with different legumes have been reported by Alalade *et al.* (2014). Improvements in nutritional composition were increases in crude-protein, and minerals (Ca, P, K, Mg, Cu, Fe and Zn). Numerous studies have proved that the nutritive value of grass herbage can be corrected by either agronomical or feeding methods. It is highlighted from this study that *Panicum sarmentosum* has very similar nutritive attributes to *P. maximum*, therefore, it is a promising species for forage uses, and comparable to the well-know forage grass of *P. maximum*. Nevertheless, studies on agronomical and biological evaluations are required for this new promising grass, *Panicum sarmentosum*. Furthermore, the finding of this current study of the similarities between the two grasses has indicated that *Panicum sarmentosum* might also eligible for uses under shaded niches. This suggestion is based on the reasons that; the current study was conducted on a coconut plantation, and *Panicum maximum* is known as a grass species with a capability to grow under a shaded condition (Durr and Rangel, 2000; Brant *et al.* 2018). Again, studies are necessitated to confirm this new hypothesis.

## Conclusion

Overall, the current study provides evidence on the potential of *Panicum sarmentosum* as a forage source for ruminant base on its nutritional composition, which are comparable to the forage of *Panicum maximum*.

Forages of both Panicum grasses had almost adequate levels of nutrients for ruminants. Except the deficient in macro-minerals (K, Mg, P, and Na), herbage of *Panicum sarmentosum* and *Panicum maximum* can satisfy the level of ruminants requirements in nutrients, macro mineral (Ca), and all micro minerals considered in this study (Cu, Mn, Fe, and Zn).

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