

## **Chemical Composition of Taiwan Napier Grass at Different Growth Stages**

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## ABSTRACT

Napier grass (*Pennisetum purpureum*) has potential to be processed as a livestock fodder due to high growth rate and good nutritive value. The objective of this study is to determine and compare the chemical composition of Taiwan Napier grass at different growth stages. The different harvesting intervals of growth stages were 30 to 35 days and 40 to 45 days. The plant samples were collected at Agropolitan Farm Besut-Setiu, Terengganu and were analyzed using proximate analysis and dry ashing method. The chemical compositions were analyzed for ash, crude protein (CP), crude fiber (CF), ether extract (EE), Magnesium (Mg) and Potassium (K). The mineral compositions of Mg and K were measured using Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES). Results showed that the chemical compositions of Taiwan Napier grass at different growth stages had a significant effect on the percentage content of all components measured. The percentage of crude fiber increased as the age increased which is 28.88% and 30.04% in 30-35 days and 40-45 days, respectively. The percentage of chemical compositions of crude protein, ash, ether extract, Mg and K had decreased as the growth stage of Taiwan Napier grass increased. The percentage of crude protein, ash, ether extract, Mg and K were higher at 30-35 days, which are 14.42%, 10.57%, 3.00%, 0.064 ppm and 0.026 ppm, respectively. Therefore, it can be concluded that the growth stage at 30-35 days of Taiwan Napier grass is the best age for harvesting which is providing high nutritive value of the animal feed.

**Keywords:** Taiwan Napier grass, fodder, harvesting ages, chemical composition, growth stages

## ABSTRAK

Rumput Napier (*Pennisetum purpureum*) berpotensi untuk diproses sebagai foder ternakan kerana mempunyai kadar pertumbuhan yang tinggi dan nilai nutrisi yang baik. Objektif kajian ini dijalankan adalah untuk menentukan dan membandingkan komposisi kimia rumput Napier Taiwan pada peringkat pertumbuhan yang berbeza. Perbezaan penuaian peringkat pertumbuhan adalah diantara 30 sehingga 35 hari dan 40 sehingga 45 hari. Sampel rumput telah diambil di Ladang Agropolitan Besut-Setiu, Terengganu dan telah dianalisis dengan menggunakan analisis proksimat dan kaedah pengeringan abu. Komposisi kimia yang dianalisis adalah abu, protein mentah, serat mentah, lemak mentah, magnesium (Mg) dan potassium (K) menggunakan Spektrometri Pelepasan Optik-plasma Tergabung secara Induktif (ICP-OES). Hasil kajian menunjukkan bahawa komposisi kimia rumput Napier Taiwan pada peringkat pertumbuhan yang berbeza mempunyai kesan yang signifikan ke atas kandungan peratusan bagi semua komponen diukur. Peratusan serat mentah meningkat apabila umur rumput meningkat iaitu 28.88% dan 30.04% pada 30-35 hari dan 40-45 hari, secara berurutan. Peratusan komposisi kimia protein mentah, abu, lemak mentah, Mg dan K telah menurun apabila umur meningkat. Peratusan protein mentah, lemak mentah, abu, Mg dan K adalah tinggi pada peringkat umur 30-35 hari. Kesimpulannya, peringkat pertumbuhan rumput Napier Taiwan pada 30-35 hari adalah usia terbaik untuk dituai kerana mempunyai nilai nutrisi yang tinggi untuk makanan haiwan.

**Kata kunci:** Rumput Napier Taiwan, foder, umur penuaian, komposisi kimia, peringkat pertumbuhan

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## INTRODUCTION

Napier grass or *Pennisetum purpureum* is currently the most popular fodder grass in dairy and feedlot production systems due to high productivity and good nutritive value (Wadi et al., 2014). The Napier grass also known as Elephant grass is a species of perennial grass which is native to subtropical Africa (Kebede et al., 2016). It has been fed using a cut and carry system to the livestock. The Napier grass is easy to grow, more adaptable and productive grass which is very suitable for the Malaysia conditions (Halim et al., 2013). The Napier grass provides a high biomass yield in most tropical and sub-tropical climates and already well-known as well as usage for livestock fodder (Ansah et al., 2010; Halim et al., 2013; Kebede et al., 2016; Rusdy, 2016). It was introduced to Malaysia in 1920's and currently used widely as a feed for livestock (Wong et al., 1982; Halim et al., 2013;

Zailan et al., 2016). The Napier grass is an important fodder in Malaysia which has been used in intensive and semi-intensive of livestock production systems to meet the increasing demand for meat and milk of livestock (Halim et al., 2013; Zailan et al., 2016). There are several species of Napier grass has potential in processing as fodder such as Taiwan Napier, Red Napier and India Napier.

Selecting the right fodder grass species is important for cultivation and must take into consideration the yield, digestibility and chemical composition of the grass. The nutritive value of grass for livestock depends upon the amount of dry matter consumed, the chemical composition and the coefficient of digestibility of the dry matter (Halim et al., 2013; Wangchuk, 2015). The understanding of chemical composition requirement is important to provide diets that appropriately meet the animal's needs, especially for the growth and milk production. The chemical compositions such as crude protein (CP), crude fiber (CF), calcium (Ca), phosphorus (P), potassium (K), magnesium (Mg) and nitrogen (N) are the most mineral needed for the animal growth, which can obtained from the animal feed such as a grass or forage (Gaal et al., 2004; Gomes et al., 2011; Halim et al., 2013; Kebede et al., 2016a). Many studies have proved that the Napier grass has a good nutritive value as well as the chemical compositions (Gomes et al., 2011; Halim et al., 2013; Lounglawan et al., 2014; Zailan et al., 2016).

However, the chemical composition of the grass has been shown to vary with the stage of maturity, soil conditions and climate (Lounglawan et al., 2014). According to Lounglawan et al., (2014), a young plant is characterized by their high protein content, ether extract, and ash, while the maturing plant have high of crude fiber content. This study also suggested that the cutting interval for young plant has a high nutrient content compared to the matured plant. Therefore, the main objectives of this study are to determine and compared the chemical compositions of Taiwan Napier grass at different growth stages which are 30-35 days and 40-45 days.

## MATERIAL AND METHODS

### Plant sample collection

An establish of Napier grass (*Pennisetum purpureum*) with two different growth stages (30-35 days and 40-45 days) were harvested manually with a sickle at Besut-Setiu Agropolitan Farm, Terengganu, Malaysia. The samples were selected randomly with 3 replications by quadrates (1x1m<sup>2</sup>). The plant samples were chopped into smaller pieces (2-5 cm) using the chopping machine. Then, the plant samples were placed into plastic bags and transferred to the Nutrition Laboratory of University Sultan Zainal Abidin (UniSZA), Besut Campus for providing materials for this study.

### Plant sample preparation for chemical analysis

The plant samples were removed from plastic bags and washed with deionized water to remove soil and dust particles. The samples were washed and rinsed with 15 seconds to avoid danger of K and Mg leaching from the tissue (Kalra, 1998).

### Chemical composition analysis

The chemical compositions of dry matter, CP, CF, fat and ash were analyzed using the proximate analysis according to AOAC (1999) procedure. In determining the dry matter, 200 g of the Napier grass sample was taken and chopped into short length (2-5 cm). The plant samples were then placed in an oven at 105 °C for 6 h (AOAC, 1999). The weight after drying is the dry matter. The CP was determined by using the Kjeldahl method according to AOAC (1999) procedure. The ash component was determined by igniting 5 gm of Napier grass sample in a muffle furnace at 500 °C for 5 h (AOAC, 1999). The residue after burning in the furnace is the ash. The mineral compositions of Mg and K were determined using the dry ashing method according to AOAC (1999) procedures and were analyzed using the Inductively Couple Plasma Optical Emission Spectrometry (ICP-OES).

### Data analysis

All data were statistically analyzed using Independent T-Test to compare the chemical compositions of Napier grass at different stages of growth by using SPSS 2.0 statistical software. The *p* value (*p*<0.05) is considered a significant difference.

## RESULTS AND DISCUSSION

### Nutritive values of Napier grass varieties

Chemical compositions of Taiwan Napier grass at different growth stages have a significant effect on the percentage content of all components measured as shown in Table 1. The crude fiber percentage increased as the age increased from 30-35 days to 40-45 days, respectively. While the moisture content, ash, crude protein and crude fat showed a decrease as the age increased. In terms of age of Napier grass in 30-35 days, which is younger and leafier plants harvested showed higher in crude protein (14.42%) and lower of crude fiber (28.88%) contents. While at the cutting interval at age 40-45 days, which is older plants showed the lower of crude protein (10.51%) and higher in crude fiber (30.04%) contents. There is a significant difference for the mean values of crude protein at level  $p < 0.05$ . While for the crude fiber, there is no significant difference in the mean values at level  $p > 0.05$ . The high content of crude protein in the Napier grass indicates the rapid growth stages of the grass.

**Table 1** Proximate compositions (%) of Napier grass at different stages of growth.

Parameters	Age	
	30-35 days	40-45 days
Moisture content (%)	88.92 <sup>a</sup> ± 1.66	85.32 <sup>a</sup> ± 1.94
Ash (%)	10.57 <sup>b</sup> ± 0.73	8.41 <sup>a</sup> ± 0.82
Crude protein (%)	14.42 <sup>b</sup> ± 0.33	10.51 <sup>a</sup> ± 0.33
Crude fiber (%)	28.88 <sup>a</sup> ± 0.41	30.04 <sup>a</sup> ± 0.67
Crude fat (%)	3.00 <sup>a</sup> ± 0.58	2.63 <sup>a</sup> ± 0.23

Notes:

Different letters in superscript (a and b) within the same row indicate significant difference ( $p < 0.05$ ) among different growth stages.

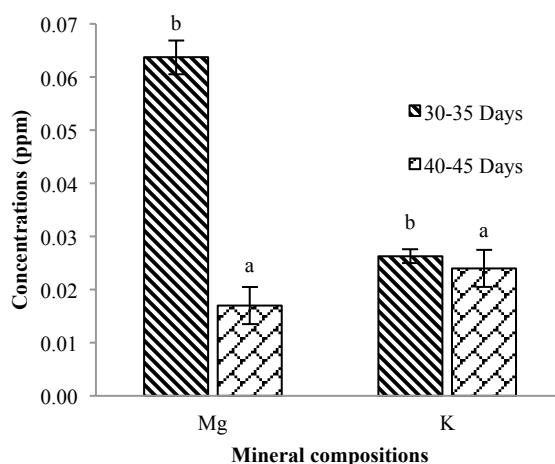
Schut et al. (2010) proved that determining the nutrient value of forage is important in livestock nutrition, because effective livestock production is related to the amount of nutrient in the forage. In the present study, the crude protein in the grass was stressed out as the component which was very important for a high quality diet feed. According to Pinkerton (2005), the crude protein is often used as indicators of forage quality. This is due to crude protein is the most essential component in animal nutrition. This component is often the critical limiting factor to the animal production. It has been recommended that, on a practical level, maximum benefit in terms of protein nutrition comes from grazing or cutting grass at early maturity of even less than 4 weeks (Halim et al., 2013). As one would expect, the crude fat of Napier grass decreased with age increased, from 3.00% to 2.63% in 30-35 days and 40-45 days, respectively. There is no significant difference in the mean values of crude fat at level  $p > 0.05$ .

For the moisture content, the Taiwan Napier grass with different stages of growth also showed there is no significantly different at level  $p > 0.05$ . The mean value of moisture content of 30-35 days of age is 88.92% while at 40-45 days is 85.32%. The result of moisture analysis obtained from this study, nearly similar to the findings by Lounglawan et al. (2014). The moisture content represents the quantity of water contained in a in the plants. Meanwhile, the mean ash value of the grass showed there is a significant difference at  $p < 0.05$ . The mean value of ash at 30-35 days of age was higher (10.57%) compared to cutting interval of 40-45 days which is 8.42%. According to McClements and Decker (2009), the higher of ash content indicated the higher minerals in the plants. Ash is considered as the total mineral or inorganic content of the sample. Determination of chemical composition in ash of leaves and stems has also been carried out to correlate nutrient uptake by plants. This was similar with the findings of Lounglawan et al. (2014) who found that ash showed a decrease as the cutting interval increased.

The mineral compositions of Mg and K are presented in Figure 2. The Mg content also higher during the cutting interval of 30-35 days compared to 40-45 days which are 0.064 ppm and 0.017 ppm, respectively. K content also showed a decreased as the age increased from 0.026 ppm to 0.024 ppm.

This result was similar to the study of Karimi *et al.*, (2012) which showed that the mineral compositions in the plants gradually decreased as maturity increased. This indicates that at the age of Napier grass increased the Mg and K contents also decreased. A plant's nutrient requirement increases with age or size during periods of exponential growth (young stage) (Wijitphan *et al.*, 2009). Therefore, the supply and uptake of nutrients must be increased to maintain maximum plant growth.

The contents of inorganic elements are very important in the plants (White and Broadley, 2009). The Mg is needed in the photosynthesis process, as it is a building block of the chlorophyll, which makes the leaves appear green, while K increases crop yield and improves the quality (Ashley *et al.*, 2005; Cakmak and Yazici, 2010). It is required for numerous plant growth processes (Cakmak, 2013). Furthermore, different stages of plant growth affect the concentration of a number of minerals in Napier grass. In the both stages, the highest content of elements was in the first stage of growth.



Error bars: SEM (The standard error of the mean)

Different letters in superscript (a and b) within the same parameter indicate significant difference ( $p < 0.05$ ) among different growth stages

**Figure 2** Mineral compositions of Napier grass at different growth stages

Furthermore, the main role of K is to provide the appropriate ionic environment for metabolic processes in the cytosol, and as such functions as a regulator of various processes including growth regulation. Plants require K ions for protein synthesis and for the opening and closing of stomata, which is regulated by proton pumps to make surrounding guard cells, either turgid or flaccid (Öborn *et al.*, 2003). Magnesium is an important part of chlorophyll, a critical plant pigment important in photosynthesis. Also, it is important in the production of ATP through its role as an enzyme cofactor (Karimi *et al.*, 2012). The values of Mg and K in this study were lower compared to the previous study by Norton (1982) which was 0.36 ppm and 1.5 ppm, respectively. The differences could be due to mineral uptake by plants is affected by several factors such as soil moisture, soil aeration and oxygen level, soil temperature and tillage system (White and Broadley, 2009). Higher soil moisture usually means greater availability of K. Increasing of soil moisture increases movement of K to plant roots and enhances availability.

## CONCLUSION

This study has shown that cutting interval has a marked effect on the chemical compositions of Napier grass. The proximate analysis result showed that at the age increased, the crude fiber percentage increased, whereas moisture content, ash, crude protein and ether extract all showed a decreased. Mineral analysis showed during 30-35 days of age has higher of Mg and K content compared to 40-45 days of age. Thus, it can be concluded that the Napier grass should be harvested every 30-35 days of cutting interval depends on the physical state of animal, species of animal and environmental factors.

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