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Characterization of chemical composition in five different Napier cultivars at different cutting ages

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The main objective of this study is to determine and compare the chemical composition of five Napier grass cultivars at different cutting ages (45 days, 60 days and 75 days). The chemical compositions of moisture, ash, crude fiber, crude protein and fat were determined by proximate analysis. The dry ashing method and Induced Couple Plasma Optical Emission Spectrometry (ICP-OES) were used to determine the mineral compositions of magnesium, potassium, phosphorus, and calcium. The results showed that the increasing of cutting ages was significantly decreased ($p < 0.05$) of the most chemical compositions of five Napier cultivars. The proximate compositions such as moisture, ash, crude protein, and fat of five Napier grass cultivars was significantly decreased ($p < 0.05$) as the age increased. However, crude fiber was increased as the age increased. The crude protein was highest in Dwarf Napier compared to other cultivars which is 25.51 %. The mineral compositions such as potassium and phosphorus of five cultivars were decreased along with maturity. From the results obtained, it is showed that Dwarf Napier was the best cultivar as animal feed and the best cutting ages was at Day 45 that will achieve the higher nutrient yields.

Keywords: Chemical composition, Napier cultivars, cutting interval

INTRODUCTION

Forages have a crucial role in the ruminant's nutrition for providing energy, protein and minerals (Jung and Allen, 1995; Gomes et al., 2011; Ogedegbe et al., 2012). Forages consist of various species which are mainly from grasses and legumes (Jank et al. 2011). The forages such as grasses are the essential feed resources in both developed and developing countries that eaten by the livestock (Lounglawan et al., 2014; Kebede et al., 2016; Rusdy, 2016).

Napier grass or scientifically *Pennisetum purpureum* is an important forage crop in the tropical and subtropical areas which contain high biomass production and high nutritive value (Orodho et al., 2006; Azevedo et al., 2012; Halim et al., 2013; Lounglawan et al., 2014; Kebede et al., 2016). Napier grass was introduced to Malaysia in the 1920s and widely used in dairy and feedlot production systems (Halim et al. 2013). According to Halim et al., (2013), Napier grass divided into two groups, which are tall and short types.

There are a few factors which can affect the nutritive value of the Napier grass such as different Napier grass cultivars and the growth stage. A few studies are comparing these two types of Napier grass effects on the chemical composition. Short type of Napier grass showed a higher nutritive value compared to the tall type

(Halim et al., 2013). Comparative studies among different cutting interval have been rarely conducted in Malaysia. A study by Lounglawan et al. (2014) found that Napier grass with the ages of 30 days to 45 days contain high protein, ether extract, and ash while the percentage of dry matter and crude fiber were highest at 60 days. However, the study only focused on the nutritive value and not measuring the other chemical compositions which are needed by the animals.

Therefore, the main objective of this study was to determine and compare the effects of different cutting ages (45, 60, 75 days) on the chemical composition of five Napier grass cultivars (Zanzibar Napier, Uganda Napier, Dwarf Napier, India Napier and Red Napier).

MATERIALS AND METHODS

Source of plant material

The stem cutting of five Napier grass cultivars (Red Napier, Dwarf Napier, Zanzibar Napier, India Napier and Uganda Napier) were collected from Department of Veterinary Besut, Terengganu and were transferred to the Universiti Sultan Zainal Abidin Farm at Pasir Akar Besut, Terengganu.

Experimental design

The five Napier grass cultivars (Red Napier, Dwarf Napier, Zanzibar Napier, India Napier and Uganda Napier) were planted at Universiti Sultan Zainal Abidin Farm in Pasir Akar Besut, Terengganu. The grasses were cut at three stages, which are 45 days, 60 days and 75 days. The experimental design was a 3×5 factorial in a Completely Randomized Design (CRD), giving a total of 15 plots. Each plot was measuring at 36 $m^{2.}$

Plant management and plant harvesting

The tillage process was conducted before the Napier grass planting. The plot was prepared by using a tractor. The stem of five Napier grass cultivars with a minimum of three nodes a piece was placed and planted at angle 30°to 40° with 15 to 20 cm length. All of the plots were weeded at the 40^{th} day. The plant samples for each variety were harvested at three different cutting ages (45 days, 60 days and 75 days) and were cut using the sickle. The plant samples were analyzed for the proximate and minerals composition at the Nutrition Laboratory, Universiti Sultan Zainal Abidin, Besut Campus.

Sample preparation and chemical analysis

The fresh plant samples were analyzed for moisture content using the AOAC (1990) method. The plant's samples were rinsed using tap water shortly before cutting into small pieces and were dried at 80 °C for overnight. Then, the dried plant samples were ground to produce powdery samples. The powdery samples were used in chemical analyses, which are proximate compositions and mineral compositions using AOAC (1990) method. The proximate composition was analyzed for the moisture, ash, crude protein, crude fiber and fat while the mineral compositions were determined aluminium, potassium, magnesium, calcium and phosphorus contents.

Statistical analysis

The data obtained were analyzed using SPSS version 25. All data were analyzed using The Generalized Linear Model with 2-factor ANOVA. The differences among mean values were tested using Tukey's LSD with $p < 0.05$. The data were analyzed using SPSS version 25.

RESULTS AND DISCUSSION

Proximate compositions

The proximate composition results of five Napier grass cultivars at different cutting ages are shown in Table 1. Based on the results, the different cutting ages had a significant effect ($p < 0.05$) on the percentage of all the components of the proximate analysis. The moisture, ash, crude protein and fat are decreased as the cutting ages increased from 45 days to 75 days while the crude fiber increased as the cutting ages increased.

Water content is known as the amount of water loss when drying until the constant weight obtained. It is essential to measure the moisture content in forage as they influence the feeds nutritional evaluation during converting to dry matter form (Anh et al., 2014). The results of this study showed that different cutting ages have a significant effect on the moisture content of Napier grass cultivars. The percentage of moisture in Napier grass was increased with the increase in cutting ages. A similar result was reported by Ansah et al., (2010), which are the moisture content, was higher when harvested at 60 days compared to 90 days and 120 days. Among the cultivars, India Napier showed the highest percentage of moisture, which is 93.84 %.

Ash defined as the total mineral in a plant (Eskandari et al., 2009). The results showed that different cutting ages have a significant effect on the ash content of Napier grass cultivars. The percentage of ash in Napier grass was increased along with maturity. This result presented was similar with the findings of Lounglawan et al.,

(2014), which found that older plants (60 days) contained the lower ash content compared to young plant (30 days and 45 days).

Table 1: Proximate compositions of five Napier grass cultivars at different harvesting ages.

Parameters (%)	Cultivars	Harvesting Ages		
		45 days	60 days	75 days
Moisture	Red Napier	74.78^{b}	87.71^{a}	^{a}86.13
	Zanzibar Napier	88.40^{a}	87.68^{b}	84.49^{c}
	Uganda Napier	92.05^{a}	85.27^{b}	80.76^{c}
	Dwarf Napier	91.17^{a}	88.29^{b}	85.14^{c}
	India Napier	93.84^{a}	86.67^{b}	84.67^{b}
Ash	Red Napier	13.81^{a}	10.37^{a}	10.20^{b}
	Zanzibar Napier	12.23^{a}	7.86^{b}	7.40^{b}
	Uganda Napier	12.02^{a}	8.59^{b}	7.15^{c}
	Dwarf Napier	15.90^{a}	13.42^{b}	^{c}10.62
	India Napier	13.03^{a}	10.55^{b}	9.80^{c}
Crude Protein	Red Napier	18.26^{a}	12.83^{b}	7.28^{c}
	Zanzibar Napier	16.78^{a}	9.12^{b}	5.70^{c}
	Uganda Napier	18.45^{a}	8.78^{b}	6.73^{c}
	Dwarf Napier	25.51^{a}	18.70^{b}	11.50^{c}
	India Napier	22.44^{a}	12.75^{b}	11.17^{c}
Fat	Red Napier	2.67^{a}	3.18^{a}	2.70^{a}
	Zanzibar Napier	3.12^{a}	2.12^{b}	1.91^{b}
	Uganda Napier	2.56^{a}	2.37^{a}	1.69^{b}
	Dwarf Napier	4.06^{a}	3.77^{a}	2.88^{b}
	India Napier	4.41^{a}	3.18^{b}	2.60^{c}
Crude Fiber	Red Napier	26.23^{a}	28.98^{b}	30.01^{c}
	Zanzibar Napier	28.15^{a}	31.28^{a}	34.08^{a}
	Uganda Napier	24.86^{a}	28.77^{ab}	31.24^{c}
	Dwarf Napier	20.12^{a}	22.59^{ab}	25.62^{b}
	India Napier	22.36^{a}	26.99^{b}	29.02^{b}

Note : Means within the same column followed by the different letters differ significantly according to Turkey at $p < 0.05$.

Among the cultivars, Dwarf Napier showed the higher percentage of ash compared with Red Napier, India Napier, Zanzibar Napier and Uganda Napier which are 15.90 %,13.81 %,13.03 %,12.23 % and 12.02 %, respectively. Protein is the most important constituent in good quality of forage and it is used by livestock for growth and production of milk (Wangchuck et al., 2015; Kebede et al., 2016).

Based on the result, the crude protein was decreased when cutting ages increased. These results were similar to the findings of Ansah et al. (2010), which found that crude protein was decreased with an increase in cutting ages. The Dwarf Napier (25.51 %) has the highest of crude protein compared to the Uganda Napier (18.45 %), Red Napier (18.26 %), India Napier (22.44 %) and Zanzibar Napier (16.78 %), respectively.

Fat or ether extract also known as a lipid component and it is important in animal body for maintenance of the body and production (Ahmed et al., 2013). The results showed that different cutting ages have a significant effect on the fat content of Napier grass cultivars. The percentage of fat was increased along with maturity. The India Napier showed the highest percentage of fat followed by Dwarf Napier, Zanzibar Napier, Red Napier and Uganda Napier which were 4.41 %, 4.06 %, 3.12 %, 2.67 % and 2.56 %, respectively.

The crude fiber showed an increased as the cutting ages increased. Lounglawan et al., (2014) findings were similar to this study which found that crude fiber were higher at 60 days compared to 30 days and 45 days. From the results presented, Zanzibar Napier has the highest of crude fiber content which are 34.08 % followed by Uganda Napier, Red Napier, India Napier and Dwarf Napier. Crude fiber includes as one of the important constituent in determining the good quality of forage and reduces the quality of forage when the content was too high (Aregheore and Hunter,1999; Ullah et al., 2010).

Minerals composition

Table 2 shows the mineral composition results of five Napier grass cultivars at different cutting ages. The results show that there is a significant difference ($p < 0.05$) of Mg, Ca, P and K content along the cutting ages, which are 45 days, 60 days and 75 days. The minerals contents of Mg, Ca, P and K were decreased as cutting ages increased while the calcium increased as the cutting ages increased.

According to Chen et al., (2017), magnesium is an essential element in plants for growth and development. It is plays a major role for protein synthesis and photosynthesis in plants. Among the cutting ages, Uganda Napier at 75 days have the higher magnesium content followed by 60

days and 45 days which are 1.12 ppm, 1.10 ppm and 0.08 ppm, respectively. This study reveals that magnesium content in India Napier (1.15 ppm) was highest among the cultivars compared with Dwarf Napier (0.96 ppm), Uganda Napier (0.88 ppm), Zanzibar Napier (0.78 ppm), and Red Napier (0.63 ppm), respectively.

Phosphorus is essential for bone and tooth formation of animals. It is one of the important constituents in Adenosine Triphosphate (ATP). The results of this study show that the phosphorus content in the Napier grass was decreased as age increased. Phosphorus content was highest when cut at 45 days. This differs from the findings of Ogedegbe et al., (2012), which found that phosphorus content in plants was increased as the ages increased. Among the cultivars, India Napier shows the highest content of phosphorus compared, which are 1.54 ppm on day 60.

The result of this study showed that potassium content was decreased as age increased. Among the cutting ages, the potassium content in Napier grass was highest when cut at 45 days which are 107.33 pm. Most of the cultivars showed a decrease of potassium content from day 45 to day 60 and increase at day 75. The Red Napier showed the highest potassium content (107.33 pm) among the cultivars. According to Prajapati and Modi (2012), potassium are important for development of plants. It is required for plant growth processes such as enzyme activation and photosynthesis (Wang et al., 2013). Potassium also important for improving the crop yield and crop quality.

The results of calcium content is significantly different ($p < 0.05$) among three different cutting ages in different cultivars. The calcium content in Napier grass was increased along maturity. This findings were similar to the results of Ogedegbe et al., (2012), which found that the calcium in plants were increased along the maturity. This study results reveal that India Napier presents the highest of calcium content (22 %). According to Soetan et al., (2010), calcium are required by animal for bone maintenance and also plays important roles for normal function muscles and nerves.

Table 2: Mineral composition of five Napier grass cultivars at different harvesting ages.

Parameters (ppm)	Cultivars	Harvesting ages		
		45 days	60 days	75 days
Magnesium	Red Napier	$^{a}0.63$	0.65^{a}	0.66^{a}
	Zanzibar Napier	$^{a}0.78$	0.90^{a}	0.63^{a}
	Uganda Napier	0.88^{b}	1.10^{a}	1.12^{a}
	Dwarf Napier	0.96^{b}	0.93^{a}	0.95^{a}
	India Napier	1.15^{b}	1.38^{a}	1.20^{b}
Phosphorus	Red Napier	1.39^{a}	1.2^{a}	0.82^{b}
	Zanzibar Napier	1.40^{a}	1.18^{a}	0.49^{b}
	Uganda Napier	1.18^{a}	1.13^{a}	0.67^{b}
	Dwarf Napier	1.53^{a}	1.23^{b}	0.79^{c}
	India Napier	1.52^{a}	1.54^{a}	0.89^{b}
Potassium	Red Napier	107.33^{a}	60.17^{b}	64.48^{b}
	Zanzibar Napier	96.39^{a}	38.35^{c}	54.16^{b}
	Uganda Napier	87.65^{a}	51.27^{b}	51.86^{b}
	Dwarf Napier	95.29^{a}	81.60^{b}	59.34^{c}
	India Napier	93.33^{a}	50.89^{b}	68.16^{b}
Calcium	Red Napier	0.17^{a}	0.18^{a}	0.18^{a}
	Zanzibar Napier	0.18^{a}	0.22^{a}	0.17^{a}
	Uganda Napier	0.15^{b}	0.17^{b}	0.22^{a}
	Dwarf Napier	0.16^{b}	0.21^{a}	0.21^{a}
	India Napier	0.22^{a}	0.26^{a}	0.26^{a}

Note: Samples presented with different alphabetic letters are significantly different ($p < 0.05$).

CONCLUSION

This study has revealed that the different Napier grass cultivar with different cutting ages have significant effect on the chemical compositions. The moisture content, ash, crude protein and fat showed decreased of their percentage when cutting ages was increased. The mineral composition of phosphorus of each cultivar was decreased when age of cutting was increased. Thus, The 45 days is the best cutting ages of Napier grass cultivars which contains of the highest chemical composition and it is showed that Dwarf Napier was the best cultivar as animal feed.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

NAK is the lead of authors who conducts the research on the field and guides the student for the field sampling, lab analysis and prepares the manuscript. NA and ANZ are second and third authors, which are undergraduate students who are conducting the lab analysis. JZ is the fourth author who is monitoring and guided the project at the field. MAMY is the fifth author who is help for lab analysis procedure.

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