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Nutrient content, fiber fraction and ethanol production of three cultivars (*Pennisetum purpureum* Scumach.)

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Abstract. This study aimed to determine nutrient content, fiber fraction, and ethanol production of three cultivars *Pennisetum purpureum* Schumach. Cultivars: tifton, king Thailand and local. The design of this study completed a randomized design of three *Pennisetum purpureum* Schumach cultivars, with three replications for each dose.Grasses were planted with space 1x1 m and then divided into three plots. Variables observed in the study included nutrient content (dry matter, organic matter, crude protein, ether extract, and nitrogen-free extract), fiber fraction (crude fiber, neutral detergent fiber, and acid detergent fiber) and ethanol production. Data obtained were statistically analyzed using analysis of variance as completed randomized design and continued with Duncan's new multiple range test for any difference detected. The results showed that cultivar's variety of napiergrass was significant ($P<0.05$) on dry matter, crude protein, neutral detergent fiber, and ethanol production. King Thailand produced the highest dry matter (20.82%), crude protein (11.85%), neutral detergent fiber (69.55%), and ethanol production (55,90 l/ton). Based on the results of the study it can be concluded that napiergrass cultivars give different results on dry matter, crude protein, neutral detergent fiber, and ethanol production. The best cultivar is King Thailand because it has the highest value on dry matter, crude protein, neutral detergent fiber, and ethanol production.

1 Introduction

Grass is the main source of animal feed plants which have the largest proportion of ruminant feed, this causes the availability of grass as animal feed must be sufficient and sustainable to support maximum livestock production. Forage feed is needed ruminants as much as 60% of the total feed needed [1].High crude fiber content in grass can be used as an energy source by ruminants in their metabolic processes in the rumen, this is in line with the government program in meeting the needs of animal protein in order to realize food independence, which is supported by the availability of feed. One effort to increase the productivity of ruminants is to provide adequate quantity and quality of feed plants throughout the year. One type of grass that has a high nutrient content and production and is favored by ruminants is napiergrass (*Pennisetum purpureum* Schumach). Napiergrass cultivars have been developed in Indonesia, many of which are new napiergrass cultivars which are the result of various plant breeding methods. It aims to create superior and quality napiergrass, so it is necessary to pay attention to its nutritional and fiber content.The fraction of each cultivator so that later the quality of each cultivar can be known, this will help in the accuracy of the utilization of napiergrass cultivars suitable for the conditions of crop cultivation by farmers.

High production accompanied by a high ratio of leaves and stems makes this grass can be used as feed ingredients for ruminants. However, not all napiergrass given to ruminants will be consumed by these animals. There are at least about 10-15% of which are not consumed or left by ruminants and in the end are not utilized by farmers. Most of the remaining napiergrass that is not consumed by livestock is grass stems that have a hard structure, so it will be difficult to consume, digest and also difficult to degrade in the rumors of ruminants.

One of the utilization of napiergrass that is not consumed by livestock is by conducting a series of bioethanol production technology processes. The fiber content in napiergrass stems is one of the ethanol-producing materials that can be used as an alternative energy source that has been proven capable of supplying liquid, solid and gas fuels for the replacement of fossil fuels. Biochemically, ethanol can be produced from ingredients that contain lots of carbohydrates through the fermentation method. *Pennisetum purpureum* Schumach suitable for use in making bioethanol because of its low ligin content and high production per harvest per year [2]. Napiergrass stems are one of the right choices in making bioethanol because they have high levels of fiber and biomass production. Based on this, it is necessary to observe the ethanol production in each elephant grass cultivar to determine the best cultivars in ethanol production.

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2 Material and methods

2.1 Material

The materials used in this study were the cuttings of three cultivars of napiergrass (tifton, king Thailand, and local), proximate analysis materials, van soest and bioethanol and manure as basic fertilizer, soil type used in the form of regosol soil using technical irrigation. The tools used in this study are tractors for cultivating land, digital analytical scales of the Sartorius brand with a capacity of 160 g with a sensitivity of 0.0001, a hanging scales capacity of 100 kg, a portable electronic scale scales capacity of 50 kg, sprinkle, chopper, willey mill with a filter diameter of 1 mm, oven 55ºC and 105ºC, furnace 550ºC, and a set of proximate analyzers, van soest and bioethanol.

2.2 Methods

It was intended to prepare the soil that will enable the seedling to grow well. The land preparation consisted of 2 main activities: weed control and soil propagation. The area was cleared out by removing all weeds and plants. . The area was then plowed and watered. After 1 week, the soil was then subjected to another plowing and watering, before in total 9 plots with an area of 1 x 1 m were made on it.Plantation was performed on the plots that had been prepared before. Napiergrass is planted using stem cuttings. Elephant grass seeds in each variety are taken from stems that are not too young, cut 10-20 cm long with the condition that each piece has 2-3 segments. Planting is done by means of seedlings lying on the surface of the soil and then hoarded. The whole plants (stems and leaves) of three cultivated napier grass were harvested with 900 grams of sanding and then chopped using chopper then dried and tested nutrien content and fiber fraction.

Sampling of napiergrass stems for each variety of 1 kg, then chopped using chopper, then the stem is naturally dried at room temperature for 2-3 days followed by oven drying at 100ºC for 3 hours.Dry samples are ground using a willey mill with a filter porosity of 1 mm. This sample was used for ethanol production from the stems of each napiergrass cultivars.The ethanol production and data collection process begin from stem samples that had been prepared were continued by a batch hydrolysis process for three days. Napiergrass samples were ground as much as 28.57 g and then mixed with a 2.85 ml concentrated HCl solution in 1 liter H2O, after that do the separation between the residue and filtrate from the hydrolysis solution using filter paper. The filtrate from the hydrolysis process is added by the Saccharomyces cerevisiae starter by 10% multiplied by the volume of the liquid, then put into the solution under anaerobic conditions for 6 days, then filtered. The fermentation process filtrate is put into 100 mlinto the distillation flask in a rotary evaporator vaccum device. This distillation process is doneat temperature of 70 - 80ºC, after 5 hours the volume of the solution was allowed 10% distillation to be stopped, then ethanol content was analyzed [3].

All data were statistically evaluated by using one-way analysis of variance for completely randomized design. The difference among groups were then subjected to Duncan's New Mutliple Range Test (DMRT). Statistical analysis was conducted by using computer program – Statistical Product and Service Solution [4].

3 Results and discussion

3.1 Nutrient content

Nutrient content in plants can be determined through proximate analysis. Proximate analysis can be used to estimate the nutrient content in a feed ingredient [5], including dry matter, organic matter, crude protein, crude fiber and ether extract, while nitrogen free extract component consists of cellulose, hemicellulose, lignin, fructant sugar, starch, pectin, organic acids, resins, tannins, pigments, and water-soluble vitamins [6].

The differences in dry matter, organic matter, crude protein, ether extract, and nitrogen free extract from the three PennisetumpurpureumSchumach cultivars can be seen in Table 1.

Table 1. Dry matter, organic matter, crude protein, ether extract, and nitrogen free extract of three cultivars *Pennisetum purpureum* Schumach

Cultivars	Nutrient content				
	Dry Matter (%)	Organic Matter^{ns} (%)	Crude Protein (%)	Ether Extract^{ns} (%)	Nitrogen Free Extract^{ns} (% DM)
Tifton	18.85^{b} ±0.18	89.15±0.86	8.90^{a} ±0.77	3.49±0.32	43.48±3.02
King Thailand	20.82^{c} ±0.71	89.22±0.57	11.85^{b}±0.40	3.50±0.59	37.78±2.17
Local	16.46^{a} ±1.46	89.33±0.94	9.35^{a} ±1.23	3.31±0.70	44.42±2.26

^{abc} superscripts on the same row indicate significant differences among cultivars (P<0.05)

A statistical analysis showed that nutrient content of three cultivars *Pennisetum purpureum* Schumach had significantly improved the drymatter and crude protein (P<0.05) – but not organic matter, ether extract, and nitrogen free extract. The difference in dry matter content in the three cultivars is related to plant growth conditions. King cultivar is a type of plant that has large plants with longer leaves in line with higher photosynthetic capacity compared to Tifton and local cultivars. The results of the photosynthesis process will be distributed to all parts of the plant so that the dry weight of the plant will increase [7]. High levels of crude protein values are also found in King cultivars compared to tifton and local cultivars.. This relates to the type of growth in these cultivars so as to affect the shape of the leaves thereby increasing the crude protein content. In addition, the root system of the cultivar is deep so that it affects plants in absorbing soil nitrogen. Nitrogen can increase vegetative growth ofplants with leaves of dense plants and greener colors, increase the quality of leaf-producing plants with higher amounts and increase levels of crude protein in plants.Napiergrass cultivars are thought to have no effect on organic matter, ether extract, and nitrogen free extract. The average content shows the same range of numbers in various cultivars.

Because all types of plants are included in one type of grass which has an influence on genetic traits in producing organic material, ether extract, and nitrogen-free extract which is almost the same and the absence of fertilizer treatment in the soil. this results in a uniform nutrient content in the soil and meets the needs of plants to form organic materials, ether extracts, and nitrogen-free extracts so as to produce the same crude oil value.

3.2 Fiber fraction

Fiber fraction is a component found in the fibers of a plant, starting from rough fibers, neutral detergent fiber and acid detergent fiber. Crude fiber is a component of plant cell walls consisting of cellulose and hemicellulose coated with lignin and silica[9]. Neutral detergent fiber is a fraction of fiber that is insoluble in neutral detergents. Neutral detergent fiber is the biggest part of plant cell wall. This material consists of cellulose, hemicellulose, lignin and silica and fibrous protein [10]. Acid detergent fiber can be defined as the number of fractions that are not dissolved after going through the dissolution process in an acid detergent solution. Cellulose and lignin are the constituent components of ADF [11]. The results of thinking of the differences in the crude fiber, neutral detergent fiber and acid detergen of three cultivars *Pennisetum purpureum* Schumach can be seen in Table 2.

Table 2. Crude fiber, neutral detergent fiber and acid detergen of three cultivars *Pennisetum purpureum* Schumach

Cultivars	Fiber fraction		
	Crude Fiber^{ns} (%)	Neutral Detergent Fiber (% DM)	Acid Detergent Fiber^{ns} (% DM)
Tifton	33.27±2.42	65.40^{a}±1.56	45,72±0,75
King Thailand	36.09±1.58	69.55^{a}±1.60	47,12±0,88
Local	32.25±1.81	63.99^{b}±2.71	44,65±2,52

^{ab} superscripts on the same row indicate significant differences among cultivars (P<0.05)

A statistical analysis showed that fiber fraction of three cultivars *Pennisetum purpureum* Schumach had significantly improved the neutral detergent fiber (P<0.05) – but not crude fiber and acid detergent fiber. The high content of neutral detergent fiber in Raja cultivars compared to other cultivars is thought to be related to the level of forage dry matter.Dry matter is a reflection of the buildup of carbohydrates. The higher the dry matter content, the higher the neutral detergent fiber [12]. Each plant cultivar has a different morphology and type of growth which can affect the plant NDF content. The difference in the proportion of stems and dry matter in plants is considered a factor in the difference in NDF content of each grass cultivar. Napiergrass cultivars are considered to have no effect on crude fiber and acid detergents, the average content shows the same range of numbers in various cultivars.

3.3 Ethanol production

Ethanol production is the result of ethanol from the fermentation process of napiergrass stems. The value of ethanol production is obtained from the multiplication of the volume of ethanol production with ethanol levels after distillation, then multiplied by the production of plant stems and converted in units of l/ton. . The results of the thought of differences in the ethanol production of the three *Pennisetum purpureum* Schumach cultivars can be seen in Table 3.

Table 3. Ethanol production of three cultivars *Pennisetum purpureum* Schumach

Cultivars	Ethanol Production (l/ton)
Tifton	35.23^{a}±5.68
King Thailand	55.90^{b}±8.02
Local	35.44^{a}±8.19

^{ab} superscripts on the same row indicate significant differences among cultivars (P<0.05)

A statistical analysis showed that ethanol production of three cultivars *Pennisetum purpureum* Schumach had significantly (P<0.05). King Thailand is the highest variety at 55.90 l / ton (P <0.05) compared to other varieties.This is because this cultivar has a high content of ADF and NDF compared to other cultivars so that it has high lignocellulose, in a series of ethanol production, lignocellulose will be converted into simple sugars (monosaccharides) so that it can be converted to ethanol. Converting lignocellulosic material to ethanol requires three key steps, namely pretreatment, hydrolysis, fermentation and product purification [13].

The initial treatment is a step taken to break down the structure of lignocellulose to obtain cellulose and hemicellulose without forming side products that can interfere with the saccharification or fermentation process. Cellulose and hemicellulose will then be broken down into simple sugars such as glucose and xylose through the process of hydrolysis saccharification with the help of acids or enzymes [14]. Simple sugars will be converted to ethanol through fermentation processes, so that high levels of lignocellulose can affect levels of lignocellulose ethanol produced.

4 Summary

As a conclusion of this study, napiergrass cultivars give different results on dry matter, crude protein, neutral detergent fiber and ethanol production. The best cultivar is King Thailand because it has the highest value on dry matter, crude protein, neutral detergent fiber and ethanol production

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