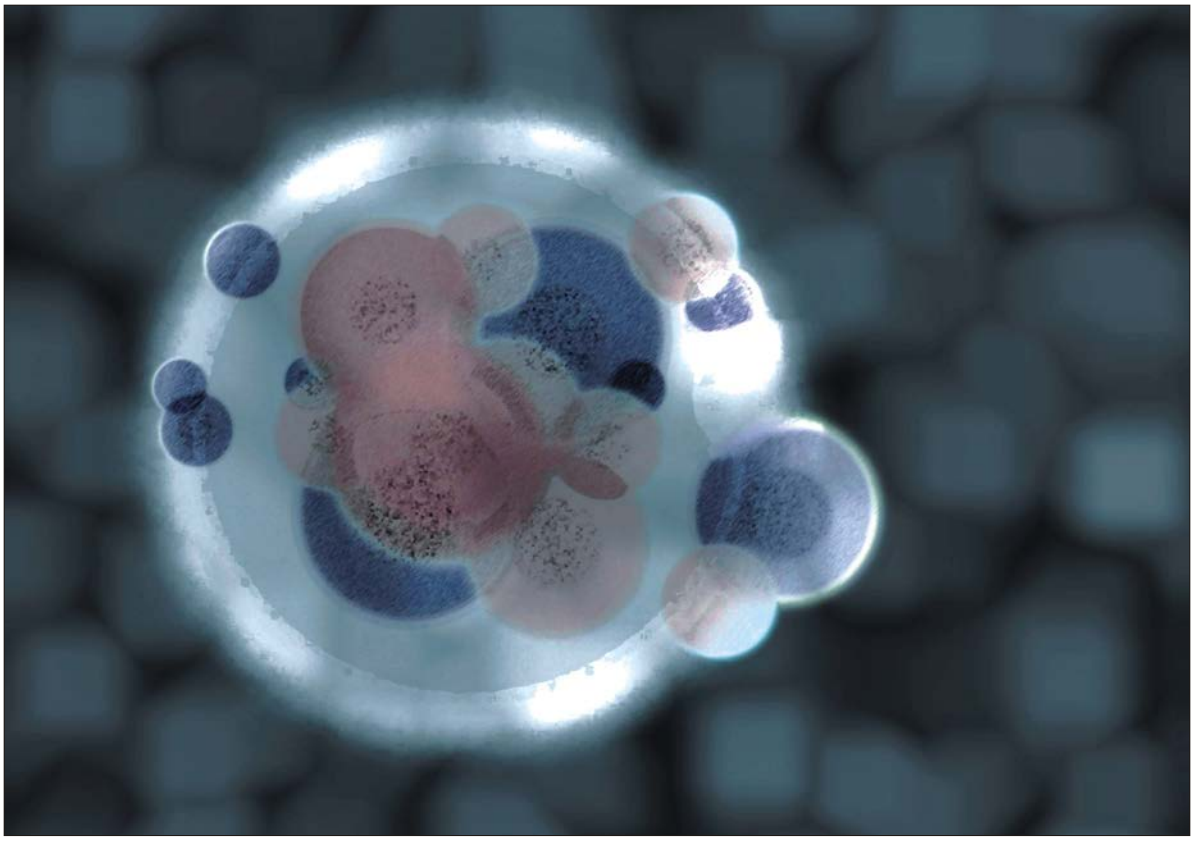

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# Chemical Composition of Napier Grass (*Pennisetum purpureum*) at Different Stages of Growth and Napier Grass Silages with Additives

A.A. Aganga, U.J. Omphile, T. Thema and J.C. Baitshotlhi
Botswana College of Agriculture, Private Bag 0027, Gaborone, Botswana

**Abstract:** The study was conducted to determine the influence of additives on the chemical composition of napier grass (*P. purpureum*) cut at five different heights of growth (50, 75 cm, 1, 1.25 and 1.5 m). They were harvested monthly from September 2003 to January 2004. The grass samples were ensiled and then analysed for the proximate composition, *in vitro* digestibility, nutrients and mineral elements. The young and immature napier grass cut at 50 cm height were highly digestible but as maturity increased, yield also increased, but quality decreased. The digestibility decreased as lignifications of the plant material increased with grass height and maturity. There was improved chemical composition and digestibility of napier grass silage cut at different heights treated with additives compared to the plain napier grass silage without additives.

**Key words:** Nutrient composition, napier grass, plant height, silage, additives

## INTRODUCTION

Grasses are the most abundant flowering plants that are useful to man. Grasses provide about 53% of the total feed units (forages and grains) consumed by all domestic livestock, in the form of pastures, native range grazing and harvested forage (hay) green feed and grass silage Grasses range from extremely persistent long-lived perennials to short lived annual completing their live cycles, opportunistically, between the onset of rains and the dry seasons[1]. Napier grass grows in the tropical and sub-tropical regions, is dependent on rainfall for high dry matter productivity. In order to ensure the availability of the grass throughout the year, the grass is either conserved as silage or hay. The grass contains fairly high moisture, which affects the fermentation of silage and hay making. Silage from a member of tropical herbage plants was stable against anaerobic decomposition, but its chemical characteristic was different from lactate-type silages of the temperate forages[1]. Napier grass has thick stolons, coarse textured and it is drought and wear resistant, very recuperative, tolerates low mowing and is hard to eradicate. Use of certain additives may be an alternative to wilting, particularly with thick-stemmed, erect fodder grasses like napier grass that produce a large mass of plant material where pre-conditioning and handling is difficult to mechanize and labour consuming.

Even under controlled wilting conditions additives are being recommended to improve fermentation and nutritive value of conventional as well as round bale silages[2]. The study on napier grass grown in Notwane farm (BCA) was conducted to determine the plant height at which it is more nutritious and to determine its suitability of silage production with different levels of additives at the evaluated plant heights.

## MATERIALS AND METHODS

Already established napier grass grown under irrigation in Notwane farm (BCA) was harvested manually with a sickle at 50, 75 cm, 1, 1.25 and 1.5 m plant heights which was about 30 days interval from September 2003 to January 2004 and collected in white sampling bags. The height of napier grass was determined by measuring the three taller tillers on each randomly selected plant. The height was measured from the base of the tiller to the top most ligule, then average sward height was determined. The fresh samples were collected in 12 bags and were cut to 2-4 cm length pieces and some were put in paper bags, then weighed in duplicates immediately after cutting. The samples were put in different plastic bags, the first two bags were control with no additives, to the third and fourth samples were added $CaCo_3$ at 0.25% the amount of napier grass, the fifth and sixth were napier grass mixed with 10% ground sorghum, the seventh and eighth plastic silos had napier grass mixed with 5% molasses, the ninth and tenth plastic silos had napier grass mixed with 1% urea and 5% molasses, the eleventh and twelveth plastic silos had mixture of napier grass with all the above additives and these samples were mixed with 10% water. All silage treatments were prepared in duplicates.

**Corresponding Author:** A.A. Aganga, Botswana College of Agriculture, Private Bag 0027, Gaborone, Botswana

Table 1: Chemical composition and digestibility of napier grass (*Pennisetum purpureum*) and silages cut at 50 cm height

| Parameters | Control | Silage 1 | Silage 2 | Silage 3 | Silage 4 | Silage 5 | Silage 6 | SEM |
|---|---|---|---|---|---|---|---|---|
| DM (%) | 37.00 | 36.00 | 35.00 | 40.00 | 36.00 | 38.00 | 41.00 | ±3.31 |
| ASH (%) | 6.00 | 6.00 | 6.50 | 7.30 | 7.10 | 7.20 | 9.30 | ±0.50 |
| CP (%) | 13.29 | 13.81 | 13.72 | 14.52 | 13.90 | 16.54 | 16.64 | ±0.83 |
| DMD (%) | 64.00 | 64.50 | 64.50 | 70.00 | 68.00 | 71.00 | 73.00 | ±6.06 |
| NDF (%) | 51.37 | 40.00 | 42.28 | 44.37 | 31.82 | 38.64 | 35.45 | ±1.44 |
| ADL (%) | 3.50 | 3.50 | 3.50 | 3.30 | 3.00 | 2.50 | 2.00 | ±0.75 |
| ADF (%) | 37.00 | 35.50 | 33.50 | 22.50 | 28.50 | 28.50 | 20.50 | ±0.98 |
| Macro elements (%) | | | | | | | | |
| P | 0.07 | 0.08 | 0.09 | 0.07 | 0.09 | 0.09 | 1.00 | ±0.04 |
| Ca | 0.11 | 0.12 | 0.19 | 0.13 | 0.13 | 0.13 | 0.16 | ±0.08 |
| Mg | 0.05 | 0.05 | 0.05 | 0.05 | 0.07 | 0.07 | 0.06 | ±0.03 |
| Na | 0.17 | 0.17 | 0.19 | 0.19 | 0.24 | 0.27 | 0.27 | ±0.08 |
| Minor elements (ppm) | | | | | | | | |
| Fe | 193.60 | 231.00 | 207.80 | 207.80 | 217.30 | 210.10 | 220.40 | ±35.80 |
| Mn | 39.00 | 40.40 | 43.50 | 43.50 | 132.50 | 136.30 | 124.50 | ±0.61 |
| Zn | 50.00 | 66.40 | 67.60 | 67.60 | 75.60 | 76.10 | 61.90 | ±0.38 |
| Cu | 6.60 | 9.90 | 6.90 | 6.90 | 8.50 | 8.0b | 7.30 | ±0.06 |

Table 2: Chemical composition and digestibility of napier grass (*Pennisetum purpureum*) and silages cut at 75 cm height

| Parameters | Control | Silage 1 | Silage 2 | Silage 3 | Silage 4 | Silage 5 | Silage 6 | SEM |
|---|---|---|---|---|---|---|---|---|
| DM (%) | 45.94 | 33.91 | 38.91 | 47.10 | 45.47 | 40.51 | 44.47 | ±2.36 |
| ASH (%) | 7.48 | 8.11 | 9.01 | 8.67 | 9.11 | 9.23 | 9.58 | ±1.21 |
| CP (%) | 10.33 | 10.20 | 10.24 | 12.15 | 11.16 | 13.74 | 14.95 | ±0.28 |
| DMD (%) | 40.00 | 45.00 | 45.00 | 51.00 | 53.00 | 54.00 | 60.00 | ±1.93 |
| NDF (%) | 64.55 | 57.27 | 57.27 | 40.00 | 49.09 | 50.91 | 39.09 | ±0.97 |
| ADL (%) | 2.00 | 4.00 | 4.00 | 3.50 | 2.00 | 3.30 | 4.00 | ±0.67 |
| ADF (%) | 33.50 | 38.00 | 38.00 | 28.00 | 28.00 | 31.50 | 25.50 | ±2.69 |
| Macro elements (%) | | | | | | | | |
| P | 0.05 | 0.06 | 0.05 | 0.06 | 0.09 | 0.08 | 0.09 | ±0.02 |
| Ca | 0.10 | 0.10 | 0.18 | 0.13 | 0.13 | 0.13 | 0.17 | ±0.07 |
| Mg | 0.05 | 0.04 | 0.03 | 0.04 | 0.05 | 0.06 | 0.08 | ±0.09 |
| Na | 0.14 | 0.13 | 0.11 | 0.19 | 1.08 | 0.70 | 0.16 | ±0.15 |
| Minor elements (ppm) | | | | | | | | |
| Fe | 192.90 | 191.00 | 215.20 | 216.90 | 220.90 | 238.90 | 246.40 | ±9.81 |
| Mn | 37.30 | 39.50 | 36.10 | 30.60 | 61.30 | 61.40 | 82.40 | ±0.25 |
| Zn | 61.20 | 64.60 | 69.40 | 63.60 | 69.80 | 64.00 | 75.70 | ±0.81 |
| Cu | 6.30 | 6.80 | 6.10 | 6.60 | 6.40 | 6.80 | 8.00 | ±0.41 |

Control = Grass, Silage 1= Plain grass, Silage 2= Grass silage + $CaCO_3$, Silage 3 = Grass silage + ground sorghum, Silage 4 = Grass silage + molasses, Silage 5 = Grass silage + urea and molasses, Silage 6= Grass silage + all additives plus water SEM: Standard error of the means

Then all the samples were shaken vigorously to make a good mixture. These were then pressed to remove air pockets in the sample; to make the mixture airtight. Then the bags were sealed and tied with a polythene string and the twelve sealed samples were then put in one plastic bag, which was sealed. The bags were placed in a secured place for 42 days for silage to be ready. After 42 days each sample was opened and analysed as described for rye grass silage[3]. Proximate analysis of the samples was done in duplicates using procedures of AOAC[4]. The dry matter, true digestibility was determined by the *in vitro* digestibility method. The constituent of acid detergent fibre and neutral detergent fibre were determined by methods of Goering and Van Soest[5]. The data was subjected to analysis of variance of SAS[6] and means values were compared using Duncan's New Multiple Range Test.

## RESULTS AND DISCUSSION

Table 1 to 5 indicates the crude protein *in vitro* dry matter digestibility acid detergent fibre, acid detergent lignin, neutral detergent fibre, ash, the major and minor minerals determined at different heights of penisetum purpureum grass and silages ensiled with different additives. Table 1-5 show improved chemical composition and digestibility of Napier grass silages harvested at different height treated with additives compared to the plain napier grass silage without additive. This is a line with the report by Muhlbach[7] that some additives improve fermentation and nutritive value of silage. There was significant increase in biomass accumulation with increased in napier grass height and maturity but this is inversely related to nutritional quality.

Table 3: Chemical composition and digestibility of napier grass (*Pennisetum purpureum*) and silages cut at 1 m height

| Parameters | Control | Silage 1 | Silage 2 | Silage 3 | Silage 4 | Silage 5 | Silage 6 | SEM |
|---|---|---|---|---|---|---|---|---|
| DM (%) | 45.99 | 48.85 | 44.87 | 40.080 | 32.74 | 39.510 | 48.05 | ±2.00 |
| ASH (%) | 8.55 | 8.60 | 10.33 | 9.540 | 9.02 | 9.810 | 9.89 | ±1.57 |
| CP (%) | 8.85 | 8.74 | 8.80 | 9.280 | 8.35 | 12.910 | 14.50 | ±0.49 |
| DMD (%) | 47.00 | 48.00 | 49.00 | 55.000 | 54.00 | 57.000 | 63.00 | ±2.70 |
| NDF (%) | 63.00 | 63.00 | 61.50 | 40.500 | 52.50 | 51.500 | 41.50 | ±1.59 |
| ADL (%) | 3.50 | 5.00 | 3.50 | 2.500 | 2.00 | 3.500 | 3.00 | ±1.27 |
| ADF (%) | 33.00 | 35.00 | 40.50 | 26.000 | 31.00 | 33.500 | 25.00 | ±5.77 |
| Macro elements (%) | | | | | | | | |
| P | 0.06 | 0.06 | 0.06 | 0.068 | 0.07 | 0.075 | 0.08 | ±0.02 |
| Ca | 0.11 | 0.13 | 0.17 | 0.140 | 0.14 | 0.130 | 0.18 | ±0.09 |
| Mg | 0.03 | 0.03 | 0.04 | 0.050 | 0.05 | 0.050 | 0.07 | ±0.04 |
| Na | 0.15 | 0.14 | 0.15 | 0.190 | 0.29 | 0.210 | 0.18 | ±0.30 |
| Minor elements (ppm) | | | | | | | | |
| Fe | 185.30 | 188.60 | 186.30 | 193.500 | 190.50 | 194.400 | 198.90 | ±4.59 |
| Mn | 30.60 | 32.50 | 31.90 | 35.700 | 54.90 | 57.400 | 65.50 | ±0.18 |
| Zn | 68.60 | 71.10 | 70.20 | 74.800 | 72.70 | 75.200 | 79.00 | ±0.28 |
| Cu | 6.90 | 7.80 | 7.80 | 9.100 | 9.00 | 8.900 | 8.50 | ±0.34 |

Table 4: Chemical composition and digestibility of napier grass (*Pennisetum purpureum*) and silages cut at 1.25 m height

| Parameters | Control | Silage 1 | Silage 2 | Silage 3 | Silage 4 | Silage 5 | Silage 6 | SEM |
|---|---|---|---|---|---|---|---|---|
| DM (%) | 35.03 | 32.36 | 38.46 | 42.94 | 38.02 | 32.10 | 47.94 | ±2.72 |
| ASH (%) | 11.90 | 12.88 | 12.88 | 13.09 | 13.02 | 13.12 | 13.31 | ±0.64 |
| CP (%) | 6.67 | 6.70 | 6.83 | 7.84 | 7.56 | 9.58b | 10.36 | ±0.38 |
| DMD (%) | 42.00 | 46.00 | 45.00 | 51.00 | 53.00 | 56.00 | 59.00 | ±4.86 |
| NDF (%) | 62.50 | 64.50 | 67.00 | 48.50 | 56.00 | 59.00 | 41.50 | ±1.13 |
| ADL (%) | 3.00 | 3.00 | 3.50 | 3.50 | 4.00 | 4.00 | 3.00 | ±1.04 |
| ADF (%) | 36.50 | 38.00 | 35.00 | 33.00 | 35.00 | 38.00 | 29.50 | ±4.85 |
| Macro elements (%) | | | | | | | | |
| P | 0.05 | 0.05 | 0.05 | 0.06 | 0.05 | 0.05 | 0.07 | ±0.06 |
| Ca | 0.11 | 0.12 | 0.17 | 0.14 | 0.13 | 0.13 | 0.16 | ±0.32 |
| Mg | 0.07 | 0.09 | 0.04 | 0.06 | 0.09 | 0.08 | 0.09 | ±0.30 |
| Na | 0.10 | 0.10 | 0.10 | 0.08 | 0.15 | 0.17 | 0.14 | ±0.01 |
| Minor elements (ppm) | | | | | | | | |
| Fe | 190.70 | 196.10 | 194.50 | 193.80 | 180.60 | 184.50 | 196.60 | ±20.81 |
| Mn | 19.70 | 23.20 | 19.50 | 19.50 | 22.80 | 22.50 | 30.30 | ±0.13 |
| Zn | 50.20 | 58.20 | 53.80 | 60.60 | 48.40 | 48.80 | 62.50 | ±0.21 |
| Cu | 10.30 | 10.70 | 10.90 | 11.40 | 10.20 | 10.60 | 11.70 | ±0.08 |

Table 5: Chemical composition and digestibility of napier grass (*Pennisetum purpureum*) and silages cut at 1.5 m height

| Parameters | Control | Silage 1 | Silage 2 | Silage 3 | Silage 4 | Silage 5 | Silage 6 | SEM |
|---|---|---|---|---|---|---|---|---|
| DM (%) | 35.27 | 39.21 | 35.74 | 40.43 | 39.57 | 36.93 | 44.070 | ±2.47 |
| ASH (%) | 12.63 | 12.42 | 13.68 | 12.82 | 12.15 | 12.27 | 14.630 | ±1.01 |
| CP (%) | 4.79 | 4.82 | 4.73 | 5.16 | 4.93 | 6.92 | 8.240 | ±0.21 |
| DMD (%) | 35.00 | 37.00 | 38.00 | 40.00 | 46.00 | 49.00 | 55.000 | ±1.71 |
| NDF (%) | 70.39 | 74.11 | 75.84 | 69.39 | 62.46 | 69.27 | 59.500 | ±1.60 |
| ADL (%) | 6.50 | 6.50 | 6.00 | 6.50 | 5.50 | 5.50 | 5.500 | ±1.55 |
| ADF (%) | 40.50 | 45.00 | 44.00 | 39.50 | 34.50 | 37.00 | 30.500 | ±5.76 |
| Macro elements (%) | | | | | | | | |
| P | 0.04 | 0.04 | 0.05 | 0.05 | 0.06 | 0.06 | 0.065 | ±0.01 |
| Ca | 0.14 | 0.14 | 0.18 | 0.15 | 0.15 | 0.16 | 0.170 | ±0.07 |
| Mg | 0.06 | 0.09 | 0.05 | 0.07 | 0.06 | 0.07 | 0.080 | ±0.03 |
| Na | 0.16 | 0.16 | 0.11 | 0.13 | 0.17 | 0.15 | 0.140 | ±0.17 |
| Minor elements (ppm) | | | | | | | | |
| Fe | 224.20 | 200.20 | 237.40 | 242.20 | 218.50 | 247.30 | 253.700 | ±46.00 |
| Mn | 62.50 | 63.70 | 66.00 | 64.90 | 69.19 | 69.20 | 70.080 | ±0.20 |
| Zn | 45.70 | 44.80 | 48.60 | 40.60 | 40.10 | 43.93 | 43.930 | ±0.09 |
| Cu | 7.30 | 8.20 | 8.60 | 7.30 | 7.30 | 7.60 | 8.690 | ±0.03 |

Control = Grass, Silage 1= Plain grass, Silage 2= Grass silage + $CaCO_3$, Silage 3 = Grass silage + ground sorghum, Silage 4 = Grass silage + molasses, Silage 5 = Grass silage + urea and molasses, Silage 6= Grass silage + all additives plus water, SEM: STANDARD error of the means

Therefore silage additives became more beneficial to improve nutritional composition of the matured napier grass. Molasses in silages is often added as a sugar additive and it increased fermentation and feeding quality of the silage[8]. It has been reported that the neutral detergent fibre contains large amounts of lignin which lowered the digestibility of the sample. It was reported that high temperatures during growth reduce dry matter digestibility because of increased amount of cell wall and lignification as well as promoting stem development[9].

Silages treated with all additives had significant increase in ash, crude protein and *in vitro* digestibility values. The use of additives improved the nutrient values of napier grass silages. It is suggested that napier grass should be harvested at 1 m height for silage making in order to have high nutritive values with relatively high biomass production.

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