

NUTRIENT COMPOSITION OF SAVANNAHS AT DISNEY'S ANIMAL KINGDOM LODGE

Shannon Livingston, MS,^{1*} Alejandra Renjifo, BS,² and Eduardo Valdes, PhD²

¹Department of Animal Sciences, University of Florida, Gainesville, 32611; ²Disney's Animal Kingdom, PO Box 10000, Lake Buena Vista, Florida, 32830

Abstract

Disney's Animal Kingdom Lodge at Lake Buena Vista Florida is home to a wide variety of animal species. Rooms at the Lodge look out over three savannah areas housing a collection of African animals. In spring 2006, a comprehensive investigation into the nutrient composition of the savannahs at the Lodge was initiated. Bermuda grass (*Cynodon dactylon*), bahia grass (*Paspalum notatum*) and limpograss (*Hemarthria altissima*) were the most commonly encountered plant species. While there were definite changes in nutrient levels observed during the study period, the majority do not appear to be related to any specific seasonal event. Crude protein levels of all savannahs showed a similar trend from February 2006 to May 2007. All three savannahs had crude protein levels around 12% (dry matter basis) in March 2006 increasing to around 20% by April 2007, then back to 15% by the end of May 2007. Acid detergent fiber (ADF) and neutral detergent fiber (NDF) levels tended to be fairly equal between the three areas. NDF values stayed fairly constant around 70% in all three savannahs. ADF values decreased across all three areas over the course of the study, as did lignin values. Starch values remained fairly consistent over all savannahs during the study period. Non fiber carbohydrate (NFC) values were much more variable during the study, yet each savannah again tended to follow a similar pattern. Mineral values varied throughout the study period, but did not show any obvious seasonal trends. Levels of calcium, phosphorus and magnesium were within the maintenance requirements of beef cattle, sheep, horses and other ungulate herbivores. Potassium levels however far exceeded amounts required for maintenance and may be an area of concern due to the potential interference with other minerals such as magnesium. Combined with the nutrient content of the animals' prepared diet, the information gathered can be used to better manage the diets of the animals living on the savannahs of Disney's Animal Kingdom Lodge.

Introduction

Disney's Animal Kingdom at Lake Buena Vista Florida is home to a wide variety of animal species. Associated with Animal Kingdom is Disney's Animal Kingdom Lodge. Rooms at the Lodge look out over three savannah areas housing a collection of African animals including birds and mammals. Species include both grazing and browsing herbivores such as giraffe (*Giraffa camelopardis*), greater kudu (*Tragelaphus strepsiceros*), bongo (*Tragelaphus eurycerus*), zebra (*Equus burchelli boehmi*) and ostrich (*Struthio camelus*).

In spring 2006, a comprehensive investigation into the nutrient composition of the savannahs at the Lodge was initiated. As the animals are on the savannahs for 22 hours each day, the potential exists for a significant portion of their intake to come from the savannah itself. From February

2006 to May 2007, biweekly samples of two different areas in each of the three savannahs were collected. Plant species present in the sample area were recorded and samples collected were sent to a commercial laboratory for analysis. All values provided are on a dry matter basis. When possible, records were also kept as to animal species that may have been grazing in each particular area.

The objective of this investigation was to record the annual fluctuations in nutrient content of pastures at Disney's Animal Kingdom Lodge in order to get a better overall picture of the nutrient intake of animals living there.

Methods

Disney's Animal Kingdom Lodge (DAKL) is located just outside of Disney's Animal Kingdom (DAK) in Lake Buena Vista Florida. DAKL exhibits a variety of African animals in savannahs adjacent to the hotel. There are three savannahs housing animals; Sunset, Arusha and Uzima. There are a variety of animals housed there, both grazing and browsing mammals as well as some birds. The animals found at DAKL are listed in Table 1.

Beginning in February 2006, biweekly sampling of the DAKL pastures was initiated. Two locations in each savannah were chosen each sample date. When possible, sample locations were chosen based on recent grazing behaviour of particular species in each savannah. Locations were recorded on a map of the savannahs. Grass height and grass composition were recorded and pictures taken as well as any available data on grazing frequency. Using either a mechanical grass cutter or hand shears (depending largely on grass height), samples of the grass were cut and collected. Sample size depended on the state of the grass (live versus some dead) and in some instances on the quantity of the grass available. The goal was to get at least 200g of fresh, green sample per location. Fresh cut samples were sealed in plastic bags and stored in a Styrofoam cooler on ice until processing. Samples were sorted for green material and oven dried for 48 to 72 hours at 55° C (HotPack oven model 217502, Philadelphia, PA). Dried samples were sent to Dairy One Laboratory (Ithaca, New York) and analyzed for acid detergent fiber (ADF), neutral detergent fiber (NDF), crude protein (CP), fat, lignin, starch, minerals and non-fiber carbohydrates (NFC). The two samples from each date were averaged to provide one value per savannah per sample date.

Part of the sample was freeze-dried (Labconco model 77530, Kansas City, MO) to be used at a later date for further analysis of fructans, starches and sugars.

Results

Bermuda grass (*Cynodon dactylon*) and bahia grass (*Paspalum notatum*) were the two most commonly encountered grass species across all savannahs, as was also found in a study of a savannah at DAK.¹⁰ Limpograss (*Hemarthria altissima*) could be found in substantial amounts in Sunset and Uzima savannahs at different times of year, more commonly during the summer months and into spring. Small quantities were found in Arusha at similar times of year. Arusha savannah, located in between Sunset and Uzima, tended to have higher proportions of dollar

weed and “other” grass and weed species than the other two savannahs. Figures 1 through 3 show the yearly distribution of grass species in the different savannahs.

CP content of the grasses followed a similar trend across all three savannahs. In February 2006, CP levels for the savannahs ranged from 9% to 12%. From March to September 2006 values ranged from 9% to 15% CP, and then started to gradually increase. By February 2007, the CP content of the areas ranged from 16% to 21%, although a high spike of 27% CP in the Sunset savannah was observed in March 2006. By the end of May, 2007 CP levels had decreased to around 15%. These values are considerably higher than values previously found on a DAK savannah, which averaged around 10%.¹⁰ CP values are shown in Figure 4.

ADF values in the three savannahs followed similar trends. Over the period of the study, ADF values decreased an average of 20%. ADF values were close to 50% in February 2006. By May 2006, ADF values had decreased to 31% to 34 %. Between July and October 2006 levels were consistently found to be between 35% and 40%. In November of 2006, values again began to decrease towards 30% where they remained throughout the remainder of the study. These are lower values than previously found for DAK savannahs.¹⁰

NDF levels in the three savannahs were consistently found to hover around 70% from February 2006 to December 2006. Values for the Sunset and Uzima savannahs started to show a slight decrease in NDF, but still remained between 60% and 70% NDF. The Arusha savannah values decreased to a low around 50% NDF in January 2007, then began a gradual increase in values to around 62% by April 2007, which is again similar to the other 2 savannahs. ADF and NDF values can be found in Figure 4.

As with ADF and NDF values, lignin and starch content of the pasture grass samples remained fairly similar across the three savannahs, as can be seen in Figure 5. The highest lignin values were observed in February 2006 when levels around 11% were recorded. Lignin content quickly decreased across all savannahs to around 5% by May 2006. Lignin values remained between 4% and 6% through May 2007. Starch levels remained between 1% and 3% for the majority of the study period. NFC levels recorded in the grass samples were much more variable than the other carbohydrate fractions that were investigated. Values are also displayed in Figure 5. Each savannah followed a similar trend in NFC content, although absolutes recorded were more varied. The highest levels for all savannahs were recorded in April, 2006 at close to 18%. Levels had decreased to below 10% by July of that year and then proceeded to fluctuate for the remainder of the study. Arusha savannah did display much higher NFC levels than either of the other two savannahs during January and February 2007, which corresponded to a difference in plant species observed during that time. Dollar weed and “other” plant species were the predominant species observed on Arusha during that time period. In comparison, Sunset contained a combination of bahia grass, Bermuda grass and limpograss while Uzima contained predominantly Bermuda grass and limpograss.

Calcium levels of the savannah grasses ranged from 0.3% to 1.0% over the course of the year. The lowest levels were found between July 2006 and January 2007, although intermittent spikes in calcium level were observed in all savannahs during this time period. Calcium levels increased to some of the higher values observed in March of 2007, yet all three savannahs had

decreased to near low levels again for April and May. Uzima savannah tended to have the lowest calcium levels of the three areas. Arusha consistently recorded the highest calcium levels, yet tended to vary in content from month to month, whereas the other two savannahs tended to show more gradual changes. Phosphorus levels ranged from 0.20% to over 0.5% of the grasses. Recorded levels had a tendency to vary more from month to month, rather than follow a trend of seasonal highs and lows. Arusha and Sunset grasses tended to vary in phosphorus content from month to month, with many hills and valleys. Uzima was somewhat more gradual in its phosphorus content changes. The calcium to phosphorus ratios of the savannahs was highest for all savannahs in spring 2006 at around 2.5:1, although one sample from Arusha in February 2006 resulted in a greater than 5:1 ratio average. From June to October, ratios ranged from 1:1 to 1.5:1. All areas showed an increased ratio in November and then decreased back to 1:1 for December. Ratios were constant from 1:1 to 1.5:1 until spring 2007, when they ranged from 1.5:1 to 2:1. Uzima consistently had the lowest calcium to phosphorus ratio except for the spike in November 2006, where it was the highest of the three savannahs at 2.5:1.

Magnesium levels of the grass samples ranged from 0.15% to over 0.45%. All three savannah areas recorded their lowest magnesium levels in the spring of 2006 and 2007. Highest magnesium levels tended to be found from July to December. Arusha consistently showed the highest magnesium levels of the three areas. Sunset and Uzima were fairly similar, although Uzima levels tended to be somewhat lower than Sunset's throughout the study period. Potassium levels were similar across all 3 savannahs and rose steadily throughout the sample period. By the end of March 2007, potassium levels had increased approximately 350%, although had started to show a slight decline in values in April and May. Mineral values are displayed in Figures 6 and 7.

Discussion

DAKL was built in 1999. All three savannahs were planted with Bermuda grass, limpoglass and star grass (*Cynodon nlemflensis*). All differences observed in grass composition are the result of new species moving into each area opportunistically. During the course of the study, Arusha was home to a higher concentration of grazing species. The grass was always shorter in Arusha than it was in either Sunset or Uzima. It is possible that the constant grazing of the grasses in Arusha, allowed for colonization of grass species that were not able to establish themselves as extensively in Sunset or Uzima. Previous studies have found that both nutrient content and grass species can be affected by herbivore use.^{2,3}

It is unlikely that any recent differences in fertilization would have been a factor, as none of the savannahs were fertilized in 2006 or 2007. Animals across all savannahs are fed similar diets, so differences in nutrients excreted onto the savannahs in feces, should not be a factor of the diet. It is possible, however, that differences in diet digestibility between the species could impact the nutrients that are excreted.³

CP levels of the grasses at DAKL were higher than those reported over an 8 month period at DAK.¹⁰ The average protein levels rose over 5% from spring 2006 to spring 2007. This corresponded to a similar decrease in ADF levels. NDF levels were fairly consistent over the study period. The lignin content of the grasses also decreased over the time period, which would

account for the decrease in ADF levels. Based on recommendations by Lintzenich and Ward,⁵ the grasses at DAKL did not meet the necessary levels of protein for ruminant herbivores in the spring of 2006. As the savannahs are not intended to be the main source of nutrient intake for the animals, this is not cause for concern. CP values did not consistently meet the recommended levels until January 2007, after which recorded values for the savannah grasses did fall within the guidelines set forth by Lintzenich and Ward.⁵ CP levels recorded at DAKL were higher than those previously reported for Bermuda and bahia grasses¹ for all but those at the 14d harvest rate. NDF levels of the DAKL grasses were higher than those reported by Dore¹ for all but the mid to late season harvests of Bermuda and bahia, but lower than those reported by Johnson et al⁴ for 1st and 2nd harvest of Bermuda or bahia grasses. ADF values recorded for DAKL savannah grasses were higher than those reported by Dore¹ for Bermuda grasses at all harvest times, but were within the range of ADF levels reported by Johnson et al⁴ for Bermuda and bahia grasses and those reported by Dore¹ for bahia grass.

All savannahs provided calcium levels within the recommended guidelines for beef cattle, horses and sheep⁶ and those recommended for ungulate herbivores.⁵ Phosphorus levels were within the requirement limits of beef cattle, but exceeded those recommended for sheep, horses and other ungulate herbivores^{5,6} for much of the year. Magnesium levels in all savannahs exceeded the recommended amounts for beef cattle and horses.^{8,9} The majority of samples in Arusha and Sunset also exceeded the recommended levels for sheep and ungulate herbivores.^{5,6} Uzima grass samples tended to have the lowest magnesium levels, yet still fell within recommended guidelines for all species, if not slightly above. Another mineral worth consideration is potassium. There have been instances of hypomagnesemia⁷ in kudu, an animal housed at DAKL. While the grass itself seems to provide adequate magnesium, potassium levels are much higher than those recommended for horses, sheep, beef cattle⁶ and a variety of exotic ungulates.⁵ Recommended potassium levels do not exceed 1.0%. Values found in the grasses are double or triple that for the majority of the study period. In comparison to a previous study of savannah grasses at DAK,¹⁰ the potassium levels recorded at DAKL were much higher. The highest potassium value recorded by Schlegel et al.¹⁰ was 1.91%. More than half of the values recorded at DAKL exceeded that amount. Over the course of the study, potassium levels increased over 350%. With the history of hypomagnesemia in some of the species that are housed on these savannahs, this increase is cause for concern as potassium can interfere with magnesium absorption and could further exacerbate the problem.

Conclusions

The savannahs at DAKL have many similarities in grass and nutrient composition. All three show similar levels of carbohydrate fractions over the study period. While NDF levels remained fairly consistent over the course of the year, levels of ADF, CP, lignin and minerals did not reveal seasonal trends. The values showed changes over the course of the study, but they do not appear to be in relation to any particular seasonal influence. Levels of CP increased from spring 2006 to spring 2007, while ADF and lignin levels decreased over the same time period. Calcium and phosphorus levels varied throughout the year, but not in an obvious relationship with any seasonal event. Magnesium levels also appeared to show no obvious fluctuations throughout the year, other than those recorded in Arusha, which were higher during the summer

and fall months. Potassium levels rose throughout the study, only beginning to decrease in April 2007.

The savannahs were not fertilized in 2006 or 2007 during the study period. The information gathered during this study reveals definite changes in the nutrient composition of the pastures which can not be attributed to fertilization of the grasses. Periodic sampling of the soil in the savannahs in addition to the grasses is being considered to see if there is a correlation. Measures are being taken to discover the source of the potassium, so as to correct the problem. Quarterly samples of the savannahs will be continued to monitor any subsequent changes in nutrient composition. Further investigation is warranted to understand the possible causes of the observed trends of nutrient composition, and take action to rectify any problems they may contribute to.

While the savannah grasses do not represent the intended diet for the animals, they have the potential to comprise a significant portion of the diet. All the animals housed at DAKL are observed to graze on the savannahs, even those not generally known as “grazers”. Changes in the nutrient composition of the grasses they graze have the potential to impact their overall nutrient intake. The information gathered in this study will be used to help evaluate the overall nutrient exposure of the animals.

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Table 1. Animal species housed at Disney's Animal Kingdom Lodge

Common name	Scientific name
Grant's zebra	<i>Equus burchelli boehmi</i>
Greater kudu	<i>Tragelaphus strepsiceros</i>
Eastern bongo	<i>Tragelaphus eurycerus isaaci</i>
Nyala	<i>Tragelaphus angasii</i>
Blesbok	<i>Damiliscus pygargus phillipsi</i>
Waterbuck	<i>Kobus ellipsiprymnus</i>
Giraffe	<i>Giraffa camelopardalis rothschildi reticulata</i>
Impala	<i>Aepyceros melampus</i>
Thomson's gazelle	<i>Gazella thomsonii</i>
Ankole cattle	<i>Bos taurus taurus ankole</i>
Eland	<i>Taurotragus oryx</i>
White bearded Wildebeest	<i>Connochaetes taurinus albo jubatus</i>
Red river hog	<i>Potamochoerus porcus</i>
Ostrich	<i>Struthio camelus</i>
East African Crowned Crane	<i>Balearica regulorum gibbericeps</i>
Stanley Crane	<i>Anthropoides paradisea</i>
Eastern White Pelican	<i>Pelecanus onocrotalus</i>
Vulturine Guinea Fowl	<i>Acryllium vulturinum</i>
Helmeted Guinea Fowl	<i>Numida meleagris reichenowi</i>

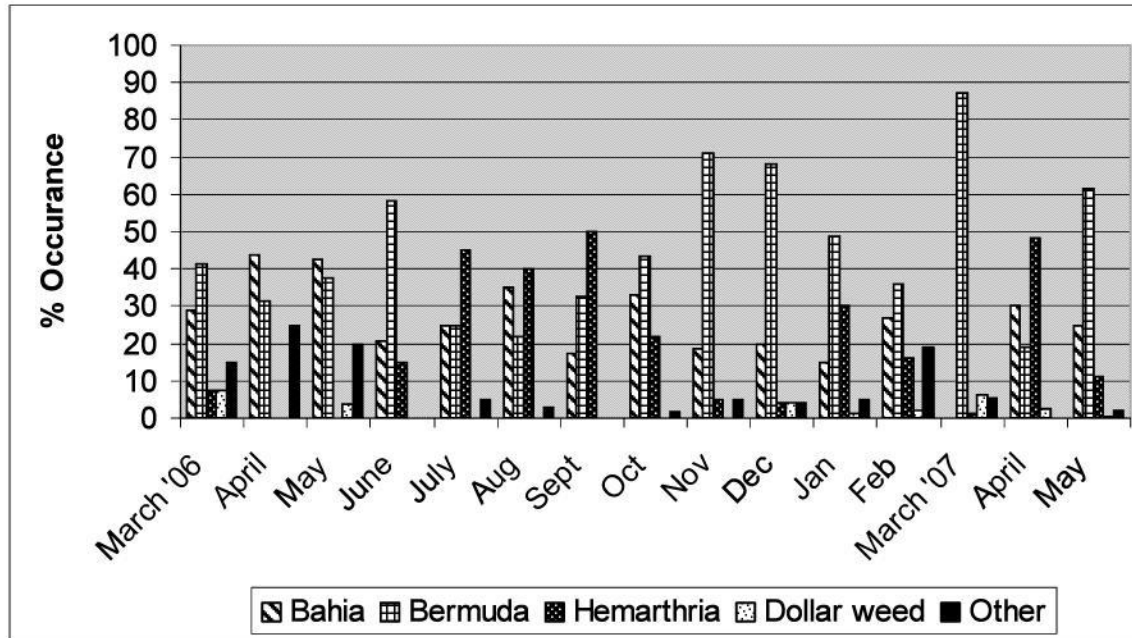


Figure 1. Plant species observed on Sunset Savannah at Disney's Animal Kingdom Lodge.

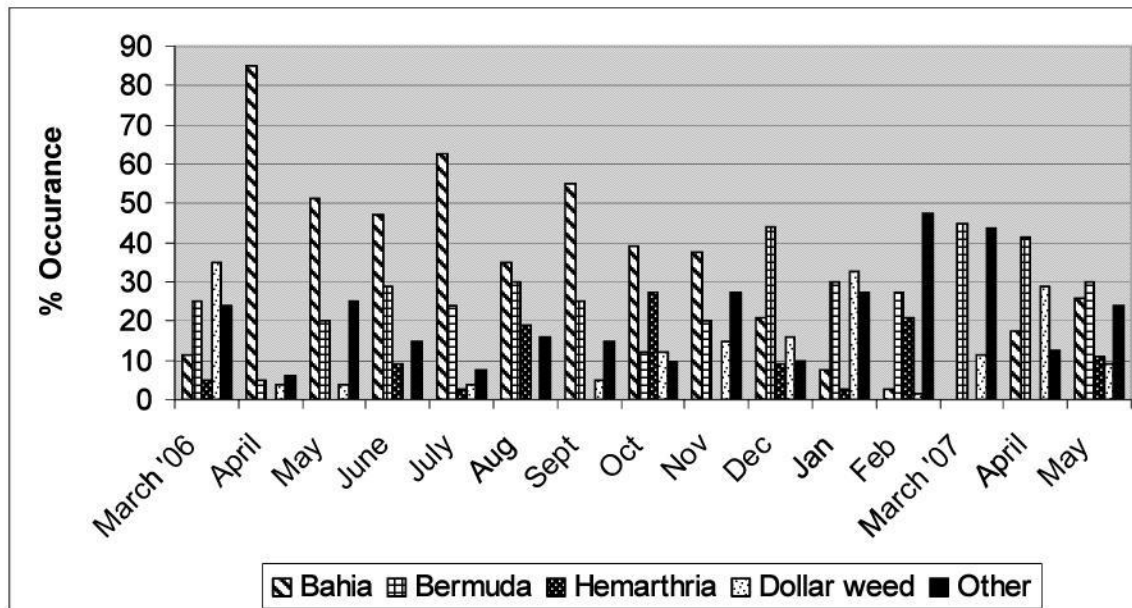


Figure 2. Plant species observed on Arusha Savannah at Disney's Animal Kingdom Lodge.

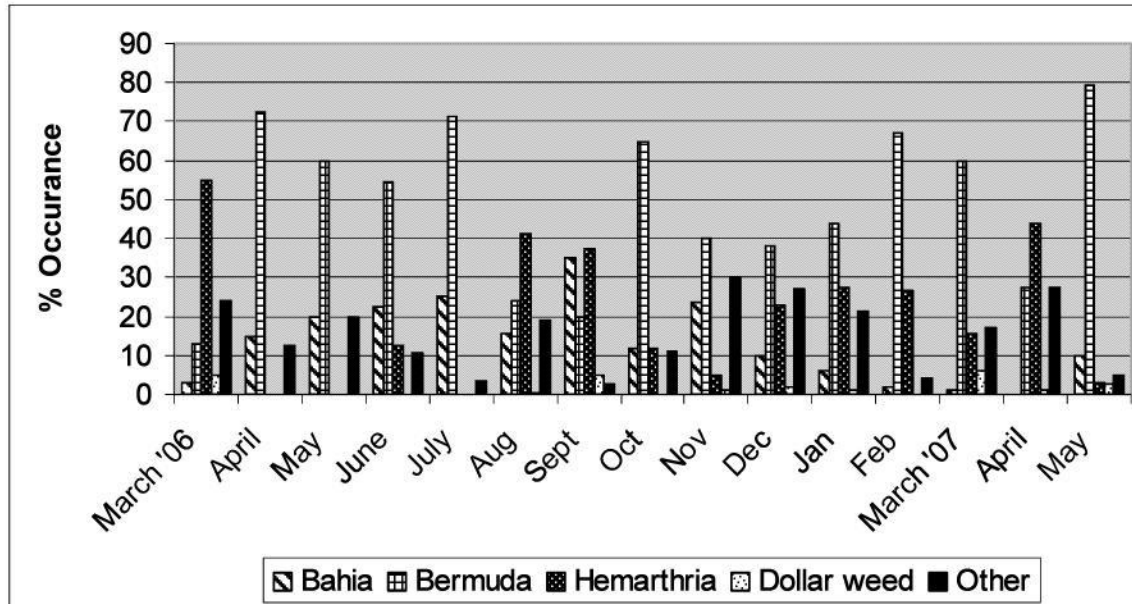


Figure 3. Plant species observed on Uzima Savannah at Disney's Animal Kingdom Lodge.

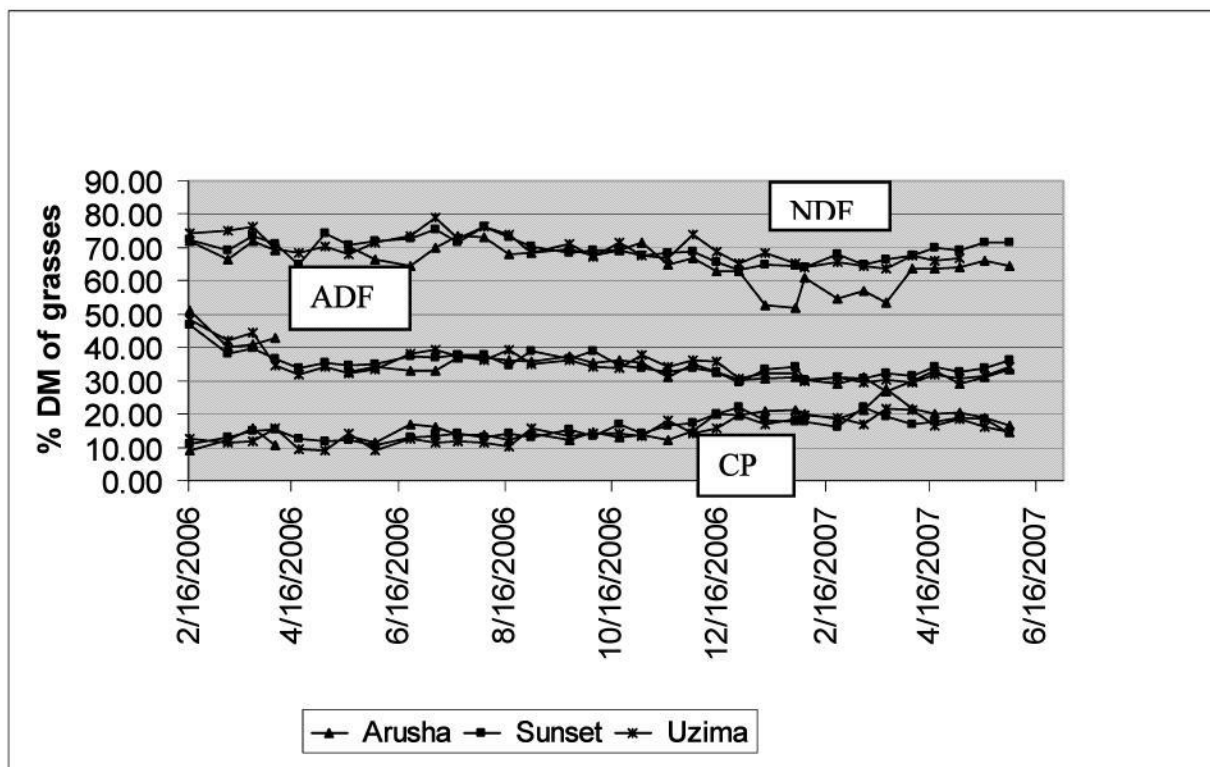


Figure 4. Fiber components and crude protein levels on a dry matter basis (DM) of Disney's Animal Kingdom Lodge savannah plants.

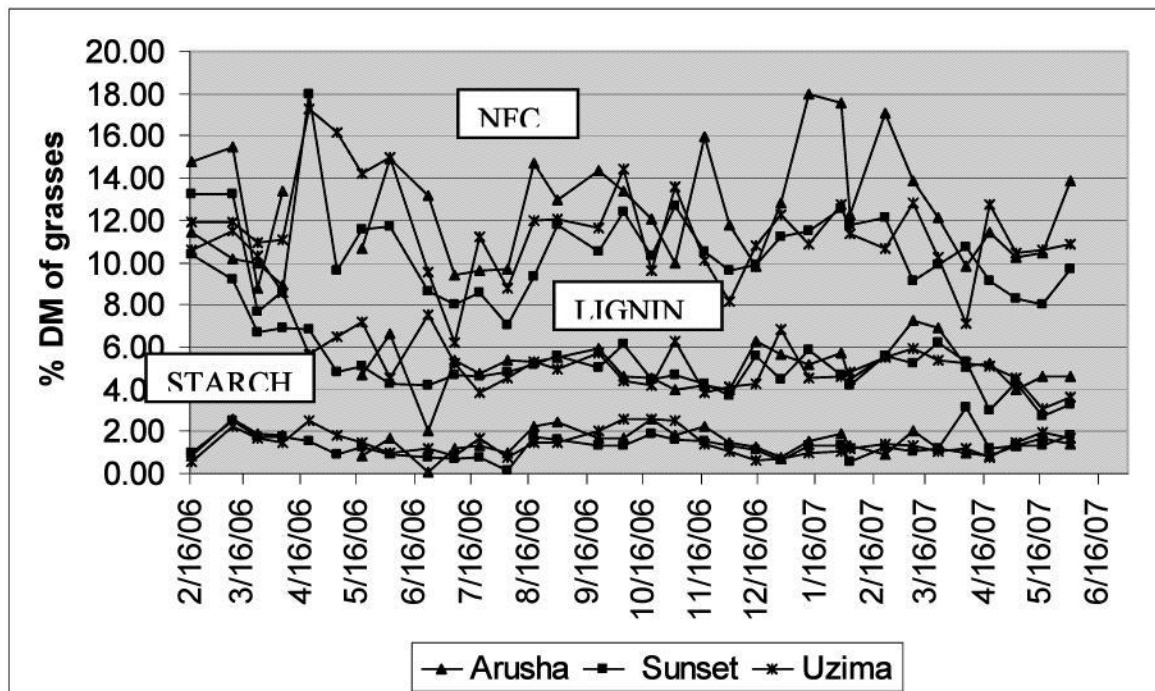


Figure 5. Starch, lignin and non-fiber carbohydrate on a dry matter basis (DM) content of Disney's Animal Kingdom Lodge savannah plants.

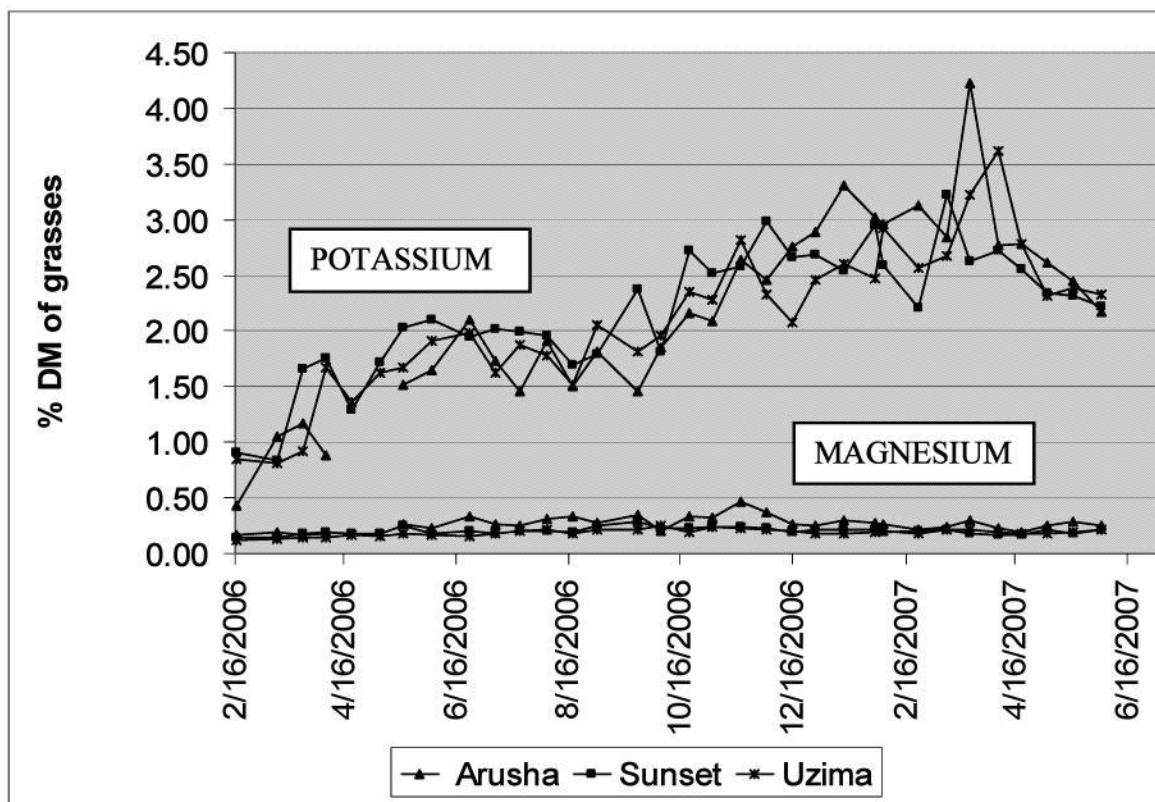


Figure 6. Potassium and magnesium levels on a dry matter basis (DM) of Disney's Animal Kingdom Lodge savannah plants.

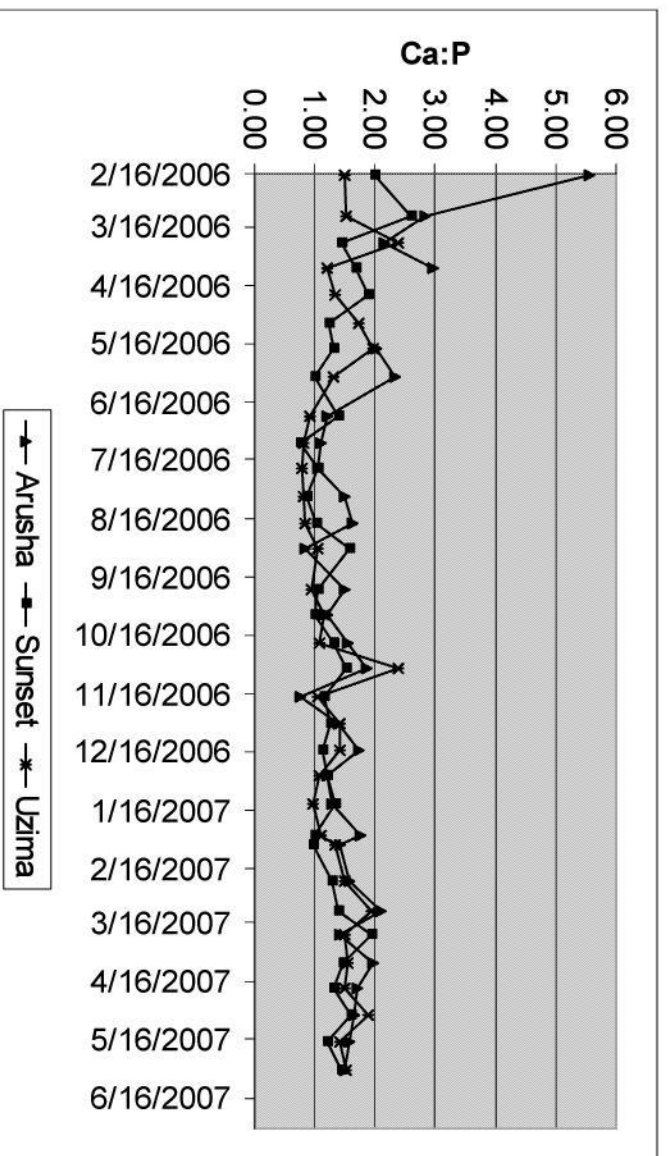


Figure 7. Calcium to phosphorus ratios (Ca:P) of Disney's Animal Kingdom Lodge savannah plants.