Seasonal and Growth Period Changes of Some Nutritive Components of Kikuyu Grass[1]

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Highlight

Changes in nutritive constituents of kikuyu grass with regrowth period and season were considered. The hemicellulose fraction of kikuyu grass collected during February and April contained xylose, arabinose, glucose, and galactose regardless of length of regrowth period. Protein decreased while fibrous components and lignin (72% sulfuric method) increased as regrowth was extended. The highest in vitro cellulose digestibility occurred at six weeks regrowth. Grazing rate or clipping practices should influence the value of kikuyu in feeding programs designed to produce acceptable beef from animals slaughtered directly from grass.

Kikuyu grass (*Pennisetum clandestinum* Hochst. ex Chiov.), a native grass of tropical Africa, was introduced in Hawaii from California about 1924. Kikuyu has become one of the major range grasses on the island of Hawaii. The extensive use of this grass appears to be based on its resistance to trampling and grazing, ability to provide ground cover against undesirable brush and especially its ability to adapt to altitudes from sea level to over 5,000 ft. Much less is known, however, concerning the nutritive value of kikuyu grass for fattening cattle on pasture. This is an important consideration since the major portion of the beef produced by the State of Hawaii is grass-fattened only. The term "grass-fattening" as used in Hawaii would mean production of slaughter cattle directly off grass which grade at least high good at approximately two years of age.

Whitney et al. (1939) noted that ranchers were in disagreement as to the nutritive value of kikuyu. Younge and Otagaki (1958) indicated that kikuyu was among the grasses which were too low in protein to meet minimum standards for young growing cattle or for fattening cattle. Ishizaki (1963) showed kikuyu grass harvested in November and December to be of lower digestibility than panicum or paragrass (*Panicum purpurascens* Raddi) harvested during January, March, July, or August. Since the carbohydrates other than crude

[1] *Approved by the Director of the Hawaii Agricultural Experiment Station as Technical Paper No. 797.*

fiber have not been studied in detail, the potential of kikuyu grass in a grass fattening program with cattle remains in doubt.

The purpose of this study was to investigate the changes occurring in various nutritive constituents of kikuyu grass with regrowth periods during different seasons. The carbohydrates of the holocellulose fractions were given special consideration.

Methods

Samples of kikuyu grass were obtained from a 0.25 acre plot, 40 ft above sea level, located at the Waialua Livestock Research Farm on the northern (windward) side of the Island of Oahu. The soil, belonging to the Waialua Family (low humic latosol derived from alluvium), was very low in phosphorus and potassium, with a moderate level of calcium. The soil had a pH of 7.2 prior to planting or fertilization. The plot received approximately 100 inches of moisture annually, 30 inches in the form of rainfall and 6 inches monthly by irrigation. Four hundred lb/acre of 10-30-10 fertilizer was applied prior to each sampling series. Samples were collected after 4, 6, 8 and 10 weeks of regrowth during February and at 6, 8 and 10 weeks regrowth in April of 1964. Although yields were generally good, no 4-week regrowth collection was possible in April. Yields of grasses for the February collections were determined to be 3,006, 7,492, 15,333 and 14,636 lb/acre for the 4, 6, 8 and 10-week regrowth periods, respectively, and 6,795, 12,676 and 23,174 lb for the 6, 8 and 10 week-regrowth periods, respectively, for the April collections. All samples were hand cut approximately 2 inches above ground level, placed in plastic bags and stored at −20 C. until dried. The samples were dried in a forced air dryer at 65 C., ground in a Wiley Mill to pass a 40 mesh screen and stored at −20 C. in capped glass jars until analyzed.

Cellulose was determined by the method of Crampton and Maynard (1938). Holocellulose was prepared by the method of Whistler et al. (1948) using 5 g samples of forage. The cellulose and hemicellulose components of holocellulose were separated and isolated according to the procedure of Myrhe and Smith (1960). Following acid hydrolysis of a 1 g sample of hemicellulose (Myrhe and Smith, 1960), the neutral sugars were separated on Whatman 3MM filter paper using a butanol-pyridine-water (6:4:3: v/v) solvent system. Duplicate 25 lambda applications of each sugar were spotted on the paper from a 10 cc solution of the syrup hydrolysate. After a 32-hr irrigation period, the chromatograms were removed and dried at room temperature. Only one of a duplicate set of chromatograms was sprayed with aniline hydrogen phthalate (Partridge, 1948) to locate the separated sugars. Each sugar was eluted from the unsprayed counterpart with 10 cc distilled water and determined quantitatively by the phenol and sulfuric acid method recommended by Dubois et al. (1956). Protein and crude fiber were analyzed by the method of the A.O.A.C. (1960). Acid-detergent fiber and lignin (Van Soest, 1963) and lignin (Patton, 1943) was also determined on all kikuyu grass collections. Forty-eight hour in vitro cellulose digestibility determinations were made according to the method of Kamstra et al. (1958).

Results

Interrelationship of Fibrous Components, Crude Protein and Lignin.—As indicated in Table 1, the fibrous components of kikuyu grass as represented by crude fiber, detergent fiber, cellulose, hemicellulose and holocellulose were affected by period of regrowth and seasons. As shown in Table 2, the crude protein decreased with regrowth interval during the December to February and February to April regrowth periods. Holocellulose and hemicellulose increased with regrowth during the December to February period and all fibrous fractions, except crude fiber, increased during the February to April regrowth intervals. Lignification increased with regrowth during the two collection periods as indicated by the 72% sulfuric acid method. No consistent increase in lignin was demonstrated by the acid-detergent method during the December collection. Many workers have demonstrated that lignin, crude fiber or cellulose increase and crude protein decrease as plants mature (Patton, 1943; Kamstra et al., 1958; Quicke and Bentley, 1959). These and other authors suggest increase in lignin as a cause for decreasing plant digestibility with approaching maturity. Kikuyu grass cellulose also shows decreasing digestibility with maturity especially after 6 weeks regrowth (Fig. 1). This could be a reflection of an increase in lignin along with a decrease in protein. It must be

Table 2. Lignin and protein content of kikuyu grass, 1964.

Growth period (weeks)	Cut. date	% of plant, dry basis SA[1] lignin	AD[2] lignin	Crude prot.
4	2-12	9.7	5.9	11.8
6	2-12	10.2	5.2	9.7
8	2-12	11.6	5.6	8.6
10	2-12	12.4	4.0	7.3
6	4- 1	14.1	3.4	11.8
8	4-15	15.8	3.7	9.4
10	4-29	16.9	4.8	6.8

[1]SA=72% sulfuric acid lignin.
[2]AD=Acid-detergent lignin.

Table 1. Fibrous fractions of kikuyu grass as determined by various methods, 1964.

Growth period (weeks)	Cutting date	Percent of plant on dry basis: Crude fiber	Detergent fiber	Cellulose	Holo-cellulose	Hemi-cellulose
4	2-12	27.1	38.8	33.4	67.4	30.3
6	2-12	28.7	38.1	32.5	67.9	35.6
8	2-12	30.2	40.5	34.5	69.6	36.6
10	2-12	30.3	37.4	36.5	72.8	36.8
6	4- 1	28.3	35.3	34.9	68.5	29.6
8	4-15	31.6	37.6	35.4	72.1	32.7
10	4-29	34.2	39.5	36.2	76.6	39.2

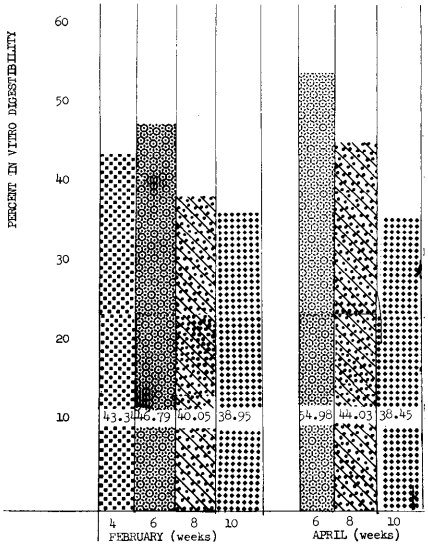

FIG. 1. Seasonal and regrowth changes in *in vitro* cellulose digestibility of kikuyu grass.

noted, however, that cellulose digestibility was higher for the 6 and 8-week regrowth periods in April than for similar periods in February even though lignification (72% sulfuric method) was higher in April. Perhaps differences in hemicellulose composition could also account for changes in digestibility or feed value as suggested by Myrhe and Smith (1960).

Neutral Sugar Components of the Hemicellulose Fraction. — The hemicellulose fractions of all regrowth stages during each collection period, upon hydrolysis, produced the neutral sugars xylose, arabinose, glucose, and galactose in order of decreasing concentration. The percentage composition of each sugar comprising the hemicellulose hydrolysate varied with growth period and season (Fig. 2). The greatest proportion of xylose in hemicellulose occurred during the eighth week of regrowth in each cutting series during February and April. Arabinose, glucose, and galactose were at their lowest levels during this period. In samples taken two weeks later, however, xylose reached its lowest concentration with arabinose and glucose at maximum levels (Fig. 1). Schentzel (1963) showed a progressive increase in the xylose and glucose content of western wheatgrass hemicellulose from June through August with a sharp decline in September. Sullivan et al. (1960) noted a marked decrease in glucose with the approach of maturity in grasses.

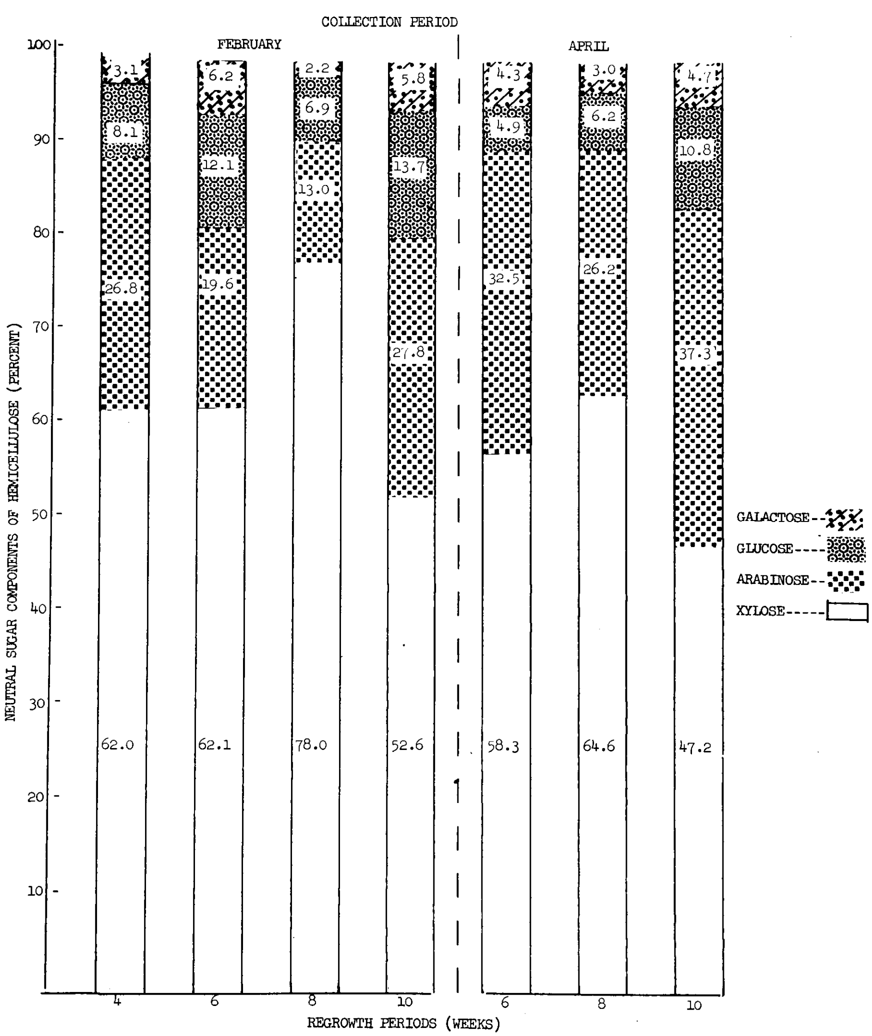

FIG. 2. Seasonal and regrowth changes in the neutral sugar components of kikuyu grass.

The sugar composition of hemicellulose which would provide maximum palatability and energy for animals has not been ascertained. The determination of the season and growth period at which the total carbohydrate content of the plant is high should be of assistance in developing a grass-fattening program for ruminant animals. It would not be sufficient, however, to consider only plant carbohydrate since other plant components such as lignin may prevent efficient utilization by animals. Factors such as altitude, soil type, or plant height may also affect plant metabolism. For example, Hosaka (1958) noted that seed production in kikuyu grass was frequent only at elevations of 3,000 ft or more. Edwards (1937) suggests that flowering in kikuyu is not usual in longer herbage.

Summary and Conclusions

A composition study was made with regrowths of kikuyu grass collected in February and April. Fibrous components, lignin and neutral sugars comprising the hemicellulose fractions were considered. Comparative 48-hour in vitro cellulose digestions were determined for each regrowth period.

Both the length of regrowth period and seasonal effects on composition were indicated. Protein decreased and fibrous compounds increased with the length of regrowth in forage collected in February and April. Cellulose digestibility was highest after 6 weeks of regrowth, then decreased at each regrowth period. The hemicellulose fractions of all collections contained xylose, arabinose, glucose and galactose. Xylose accounted for the greater proportion of the sugars and its concentration increased up to 8 weeks of kikuyu regrowth regardless of collection date. It would appear that the hemicellulose sugars found in the tropical kikuyu grass are also present in the grasses growing in more temperate climates although the relative concentrations of individual sugars with growth period and season may well be different. Temperate climates provide seasonal resting or dormant periods for grasses whereas the seasons of the Hawaiian Islands are marked only by changes in the length of daylight, moisture and minor temperature variations. Under such a continuous growing regime, range grasses including kikuyu could be subjected to year-long grazing. Proper grazing or clipping practices, fertilization, and periodic resting should increase the value of this grass. Considering its digestibility and composition, a rotation grazing system allowing 6 to 8 weeks of rest for regrowth followed by a short period of close grazing or mowing would be suggested for maximum utilization. Kikuyu has a tendency to become woody and matted if allowed to mature and even the less mature forage is considered to be of only medium palatability (Hosaka, 1957). Mixing legumes with kikuyu pasture would compensate for any lack of protein. Ranchers criticize kikuyu for being too aggressive in mixed-grass pastures. Proper management and more knowledge concerning its nutritive potential at any particular growth period or season should reaffirm kikuyu as an important range grass, especially for areas not suited for other grasses or where weed control is difficult.

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