*Short Communications/ Kort Mededelings*

# The chemical composition and nutritive value of kikuyu pasture

T.J. Dugmore & J.H. du Toit

Department of Agriculture & Water Supply, Private Bag X9059, Pietermaritzburg, 3200 Republic of South Africa

*Received 14 May 1987; accepted 26 October 1987*

The relationship between the chemical composition of kikuyu and the dry matter intake (DMI), digestibility of the chemical fractions and digestible organic matter (DOM) of kikuyu was investigated. The chemical composition and *in vivo* digestibility of kikuyu were determined throughout the growing season using six steers per digestion trial. A total of 17 digestion trials were conducted over three seasons. The DOM values for the kikuyu ranged from 56 – 64% on a dry matter basis. No significant relationship could be for any of the chemical fractions on DOM, whereas the relationship between crude protein (CP) and digestible crude protein (DCP) was explained by the equation: DCP (%) = 0,864 CP(%) - 3,494; $r$ = 0,991; $P$ < 0,001. The DMI of kikuyu was negatively correlated to the non-protein nitrogen content of the herbage ($r$ = -0,78; $P$ < 0,05). Milk production data have not substantiated the relatively high DOM values recorded over the season, particularly in autumn.

Die verwantskap tussen die chemiese samestelling van kikoejoe en die droë materiaalinname (DMI), die verteerbaarheid van die chemiese fraksies en die verteerbare organiese materiaal (VOM) is ondersoek. Ses osse is gebruik om die chemiese samestelling en *in vivo* verteerbaarheid van kikoejoe oor die groeiseisoen te bepaal. Sewentien verteringsproewe is oor drie seisoene uitgevoer. Die VOM-inhoud van die kikoejoe het tussen 56 en 64% op 'n droë materiaal basis gevarieer. Geen betekenisvolle verwantskap is tussen die chemiese samestelling van kikoejoe en VOM gevind nie, terwyl 'n betenkenisvolle verwantskap tussen die ru-proteien (RP) en verteerbare-ruproteien (VRP) bestaan het; VRP(%) = 0,864 RP(%) - 3,494; $r$ = -0,991; $P$ < 0,001. Die droë materiaalinname van kikoejoe was negatief gekorreleerd met die nie-proteïen stikstofinhoud van die weiding ($r$ = -0,781; $P$ < 0,05). Melkproduksiedata het nie die relatiewe hoë VOM-waarde van kikoejoe oor die groeiseisoen bevestig nie, veral nie gedurende die herfsperiode nie.

**Keywords:** Kikuyu, nutritive value, dry matter intake, milk production

Kikuyu (*Pennisetum clandestinum*) is well adapted to the Natal Midlands, with a particularly high dry matter production. It therefore forms an important component in the fodder flow of the local dairy herds. Any improvements in animal production from this grass will have considerable impact on the profitability of the local dairy industry, which is primarily based on kikuyu pastures.

The chemical analysis of clipped kikuyu grass samples taken throughout the growing season indicates that it is equivalent in chemical composition to Italian Ryegrass (*Lolium multiflorum*). In grazing trials on the Cedara Agricultural Research Station ryegrass supplied sufficient nutrients for maintenance and the production of 16 l of milk. Grazing trials on kikuyu with lactating cows at Cedara showed that the production from kikuyu grazing was considerably less than anticipated. The actual milk production attained was 11 l for the spring period until 25 December, 9 l from the 25 December to 15 February and 6,8 l after 15 February and for the remainder of the growing season (Warren, 1972).

In this research project the chemical composition and *in vivo* digestibility of kikuyu were determined throughout the growing season, to explain the differences that have been observed in the seasonal milk production of cows grazing kikuyu. The effect of the chemical composition of kikuyu on the digestibility of the chemical fractions, digestible organic matter (DOM) and dry matter intake (DMI) of kikuyu was investigated.

Six Hereford steers were used per digestion trial. The steers had been adapted to the digestibility crates and were fed kikuyu grass throughout the season, either by grazing or by feeding freshly cut kikuyu during the digestibility trials. The kikuyu was cut daily, at a height of 5 cm, using a mower. The cutting rotation was as similar as possible to the grazing rotation of the Cedara dairy herd, *viz.* 3 – 4 week rotation, depending on availability. The freshly cut herbage was made available to the animals by 10h00, in sufficient quantities to allow for 20% refusals.

A total of 17 digestion trials were conducted over three growing seasons, nine in the first, three in the second and five in the third. The trials were conducted throughout the growing season.

The procedure described by Bredon, Juko & Marshall (1961) was used for the digestion trials. The quantities of herbage on offer, herbage rejected (orts) and faeces were recorded daily during the digestion trial. Samples of each of these were taken for analysis. The samples were analysed for crude protein (CP) (Kjeldahl procedure, AOAC, 1965), true protein (TP) (Cupric hydroxide procedure, AOAC, 1965), crude fibre (CF) (Bredon & Juko, 1961), ether extract (EE), dry matter (DM), and ash (AOAC, 1965). Non-protein nitrogen (NPN) and nitrogen-free extract (NFE), total digestible nutrients (TDN), and digestible organic matter (DOM) were calculated from the analytical results.

The digestion coefficients calculated were based on the chemical composition of the grass actually eaten and not of that 'on offer'.

The chemical composition and digestibility coefficients of the dry matter, organic matter (OM), CP, EE, CF and NFE, as well as the DOM and TDN values of the kikuyu ingested by the steers are presented in Table 1. The chemical composition of the grass on offer differed from that of the orts, indicating that selection had taken place.

The apparent digestibility of the CF fraction was high (70,28 ± 2,95) and was slightly higher than that of the NFE (68,67 ± 2,59). These coefficients differ from the accepted norm for these fractions, in that CF digestibility is expected to be low and that of NFE to be high (Schneider & Flatt, 1975). Similar results were found by Dugmore, van Ryssen & Stielau (1986) for kikuyu and

**Table 1** The chemical composition, digestion coefficients, DOM and TDN of the kikuyu herbage ingested by the steers in the digestion trials (DM = 100)

| Chemical fraction | Range | Mean % | SE | Digestion coefficient | SE |
|---|---|---|---|---|---|
| CP | 12,7 – 23,3 | 18,7 | 3,43 | 66,86 | 4,88 |
| NPN | 0,41 – 1,05 | 0,78 | 0,15 | — | — |
| CF | 21,1 — 30,3 | 24,4 | 2,42 | 70,28 | 2,95 |
| EE | 1,20 – 3,68 | 2,85 | 0,59 | 60,95 | 7,80 |
| NFE | 38,9 – 47,6 | 42,3 | 2,84 | 68,67 | 3,76 |
| OM | 86,8 – 90,7 | 88,4 | 1,26 | 68,70 | 2,59 |
| DOM | 56,1 – 64,3 | 60,7 | 2,31 | | |
| TDN | 58,3 – 66,4 | 62,9 | 2,41 | | |

for other tropical species by Lander & Dharmani (1931), French & Rogerson (1955), Quarterman (1961) and Swart & Joubert (1964). The digestibility of the CF fraction is apparently inhibited with increasing NPN levels in the herbage (CF digestibility coefficient = 77,83 - 11,07 NPN%; $r$ = -0,63, $n$ = 12, $p$ < 0,05). However, the total N fraction was not significantly associated with decreasing CF digestibilities as found by Dugmore, *et al.* (1986).

The CP and digestible crude protein (DCP) fractions were significantly correlated and related by the equation DCP% = 0,864 CP - 3,495; $r$ = 0,991 ($P$ < 0,001). This equation provides lower values than that for tropical grasses derived by Milford & Minson (1965), *viz.* DCP (g/kg) = 0,899CP - 32,5; RSD = 0,84. These equations differ from those derived from temperate grasses by Holter & Reid (1959) (DCP(g/kg) = 0,929CP - 34,8; RSD = 0,46) and South African feeds by van Niekerk, Smith & Oosthysen (1967) (DCP% = 0,94CP - 3,26; $r$ = 0,994).

The TDN and DOM values were significantly correlated and related by the following equation: TDN = 1,439 + 1,012 (DOM); $r$ = 0,968 ($P$ < 0,001). This equation differs somewhat from that found between TDN and DOM for kikuyu using sheep (TDN = 4,66 + 0,94 (DOM); $r$ = 0,991; $P$ < 0,001; Dugmore, *et al.*, 1986). The TDN and digestible dry matter (DDM) values were also significantly correlated. TDN = 17,768 + 0,672 DDM; $r$ = 0,790 ($P$ < 0,001). This equation produces similar TDN values from DDM to that of Bredon, Harker & Marshal (1963): TDN = 7,76 + 0,819 DDM; $r$ = 0,988.

The relationship between the chemical fraction and DOM is presented in Table 2. No significant relationships were found between the relevant chemical fractions of kikuyu and its DOM content. This agrees with the work of Olubajo, van Soest & Oyenuga (1974) who found that the *in vivo* DDM of four tropical grasses was not significantly related to any compositional parameter or *in vitro* digestibility, and concluded that the discrepancies they found between *in vivo* and *in vitro* digestibilities reflect a problem in understanding and evaluating tropical forages, which have little parallel in temperate regions.

**Table 2** The relationship between the chemical fractions and DOM ($y$) in kikuyu grass

| Chemical fraction | Regression | Correlation coefficient | Significance |
|---|---|---|---|
| CP | $y$ = 62,8 – 0,11 CP | –0,165 | NS |
| NPN | $y$ = 65,3 – 6,01 NPN | –0,491 | NS |
| CF | $y$ = 61,2 – 0,02 CF | –0,021 | NS |
| NFE | $y$ = 50,3 + 0,24 NFE | 0,303 | NS |
| EE | $y$ = 60,3 + 0,14 EE | 0,036 | NS |

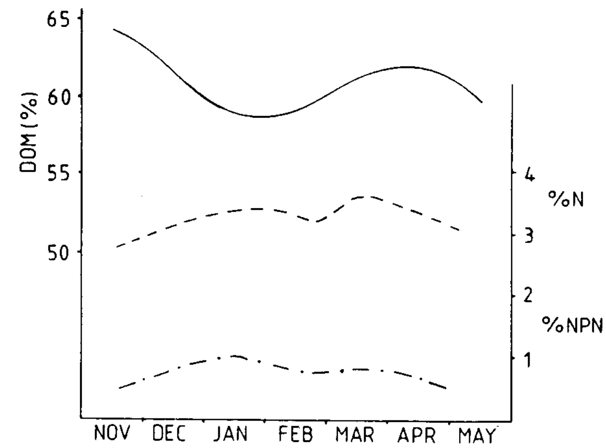


**Figure 1** The DOM (—), N (- - -) and NPN (- · -) contents of the kikuyu over the growing season

The trends over the growing season for the DOM, NPN and CP (expressed as N) values for the kikuyu grazing are illustrated in Figure 1, from which it is evident that there is a peak in the N content during autumn. This peak in the N content corresponds with the results of Marais, Figenschou & Dennison (1987). The DOM values for kikuyu over the growing season have two distinct peaks, one in spring and the other in autumn (March).

The voluntary DMI of the steers in the digestion trials was measured daily. The mean DMI was 1,95 ± 0,21 with a range of 1,56 – 2,14% of body mass. The DMI's were expressed as a percentage of body mass (BM) to overcome changes in live mass over the season. A negative relationship was found between NPN levels in the kikuyu dry matter and DMI. The nine digestion trials conducted during the first season were selected to avoid seasonal effects confounding the results This relationship is:

DMI (% of BM) = 2,794 - 1,092 NPN (% DM) ; $r$ = -0,781, $n$ = 9 ($P$ < 0,05)

Milk production trials (Warren, 1972) and the 'autumn slump' in milk production experienced by Natal dairy herds grazing kikuyu, including the Cedara dairy herd during the trial period, contradict the relatively high DOM values recorded in autumn. The lower than expected milk production could be a consequence of lower DMI in late summer and autumn when NPN levels are high. Pattinson (1981) found that the DMI of kikuyu grazing during autumn was lower than midsummer, even though the kikuyu was potentially of better quality (higher CP and lower CF) in the autumn. Pattinson (1981) suggested that some factor in the nitrogen fraction was responsible for the lower intake during autumn on kikuyu pastures.

The autumn slump in milk production could reflect poor grazing management, allowing the grass to become rank. The autumn slump has largely been overcome in the Cedara herd since 1982/83 by the use of electric fencing on pasture to restrict the grazing area and the use of follower animals in the earlier part of the season to prevent a mat of old dry material occurring later in the season. This practice was used by Moses (1934) at Umbogintwini, where horses, mules and draft oxen were used to graze residual grass after beef steers had utilized the kikuyu pasture. An inverse Ca:P ratio and an ionic imbalance (K/(Ca + Mg) > 2,2), which deteriorates as the season progresses (Miles, Bartholomew, Bennet & Wood, 1985) could also contribute to poor milk yields in autumn, if not adequately corrected in the diet.

Animal production is largely determined by the amount of digestible material consumed by the animal. It is not possible to determine the nutritive value of the feeds by *in vivo* methods under all circumstances. Various methods have consequently been devised to predict the nutritive value of the feeds. The use of the chemical fractions in the feed to predict its digestibility is a well established practice even though the use of fibre to predict digestibility is not based on any solid theoretical basis, other than statistical association (van Soest & Robertson, 1980). Rohweder, Barnes & Jorgenson (1978) recommended the use of neutral detergent fibre (NDF) and acid detegent fibre(ADF) to determine hay standards for hay marketing in the USA. Coppock, Woelfel & Belyea (1981) reported that there were two widely used laboratory methods for determining forage net energy values, both related to fibre content, in the USA and Canada. WISPLAN (a dairy feeding programme) in Wisconsin uses NDF to predict DMI and ADF to estimate DDM for its feeding recommendations (Howard and Wollenzein, 1986). Minson (1982), in an extensive review on the effect of chemical composition on feed digestibility, showed that the digestibility coefficient of a chemical could be accurately predicted from the level of the chemical fractions in the herbage, but the DDM and DOM values were estimated from the chemical fractions with diminished accuracy. The present data confirms that the chemical fractions can predict their own digestibilities with accuracy, while no significant relationships existed between the chemical fractions and the DOM value of the herbage. The present and previous data (Dugmore, *et al*, 1986) show that predicting the DOM of kikuyu using the chemical composition of the herbage is not valid and could have unexpected results.

The use of regression equatuions to predict the digestibilty of herbage from its chemical composition (e.g. TDN = 75,1 + 6 log CP% - 0,75 CF%; Bredon & Meaker, 1978) have been used extensively in South Africa, even in scientific publications, to predict the digestibilty of feeds, including kikuyu. The Bredon & Meaker (1978) and other equations have recently been tested against local feeds of known *in vivo* digestibilities at Cedara (Dugmore, in press). The equations proved relatively successful in estimating the digestibility of hays, but unsuccessful in estimating the digestibility of silages, green grazing (especially kikuyu) and fresh forages. This beares out Dewhurst, Webster, Waiman & Dewey's (1986) criticism of the use of modified acid detergent fibre in the UK to predict the ME of forages from simple linear regressions, as they considered these equations to be of limited use in practice because the precision is low and they give rise to large systematic errors when applied to data sets other than those used to derive them.

In conclusion, animal production trials have not confirmed the quality measurement of kikuyu, both by chemical analysis and *in vivo* digestibility trials, and caution must be exercised when predicting the digestibility of kikuyu from chemical analyses. The autumn slump in milk production might not be the result of a decline in the digestibility of the kikuyu *per se*, but might reflect the effect of high NPN levels on DMI, poor grazing management, or imbalances in mineral and ionic balances on animal production.

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