EVALUATING THE POTENTIAL OF *TRIDAX PROCUMBENS* FOR LIVESTOCK FEED. II. SEASONAL CHANGES IN THE CHEMICAL COMPOSITION

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ABSTRACT

Seasonal changes in chemical composition represented by crude protein (CP), *In vitro* true digestibility (IVTD), and fibre components measured by neutral-detergent fibre (NDF), acid-detergent fibre (ADF) and lignin were evaluated at specified canopy ages and stages of maturity in *Tridax procumbens*. Samples were selected from five harvest dates in April, June, August, October, and December. Chemical composition was highly responsive to dates of harvest. The stage of maturity of canopies reached significantly higher values in August than in the other months of the year. Associated with these were lower CP and IVTD and high NDF, ADF and lignin. The potential value of *Tridax procumbens* lies in a properly structured management system that optimises its quality attributes.

INTRODUCTION

More information is required about what controls the quality as well as the quantitative associations that exist between the phenology of growth and development of the plant and chemical composition on a wide range of harvest dates and seasons of the year. In the previous study in this series (Kalu *et al.*, 1986) a quantified morphological stage of maturity system for *Tridax procumbens* was defined and tested for its consistency in relation to changes in chemical composition of individual stages present in a herbage of a specified age. Herbage materials of the same age that differ in stage classes have different concentrations of measured quality components (Deinum 1966; Deinum *et al.*, 1968; Faix 1974; Van Soest 1978, 1982). These interrelationships have not been determined for different harvest dates during a growing season. The present work was designed to determine the seasonal variations in chemical composition of ***Tridax procumbens*** represented by crude protein, *in vitro* true digestibility, and fibre. This would enable the evaluations of management alternatives needed for a better asessment of the plant's potential for use as livestock feed.

MATERIALS AND METHODS

Herbage samples of *Tridax procumbens* used in this study were collected from the established stands seeded in April 1985. The experimental layout and sampling procedure were the same as those already described by Kalu *et al.* (1986). A randomized complete block design with four replicates and five treatments was used. Treatments were represented by five harvest dates (29 April, 24 June, 19, August, 28, October, and 9 December 1985). On each harvest date. three morphological stages – vegetative, flower bud, and full bloom stages were each selected from herbage materials from canopy ages of 28, 42, and 56 days. With this, it was possible to group together samples from the same canopy age, or the same stage of maturity but differing in dates of harvest. The mean stage of th total herbage of each specified canopy age was calculated for each harvest date using the equation already described by (Kalu *et al.* (1986). Sample treatment before laboratory analysis has been described in detail elsewhere by Kalu *et al.* (1986). The kjeldahl method according to AOAC (1976) and the Goering and Van Soest method (1970) were used to estimate the crude protein, and the *in vitro* true digestibility and fibre concentrations respectively. The fibre components analysed were the total cell wall or neutral detergent fibre (NDF), ligno-cellulose or acid detergent fibre (ADF) and lignin. For each parameter, total herbage composition was calculated using the equation already described by Kalu *et al.* (1986).

RESULTS

In this study, measures of crude protein, *in vitro* true digestibility, and fibre components for any common age of herbage, or stage of maturity varied with dates of harvest.

Herbage materials of the same age but differing in dates of harvest generally reached significantly higher mean stages in August than in other months (table 1). Mean stage significantly ($P < 0.05$) increased with the months of harvest from April reaching a peak in August and generally declined thereafter. Associated with these were corresponding decreases in CP and IVTD, and increases in fibre concentrations from April to August. For both CP and IVTD, significantly lower values were observed in August. For all herbage ages, there was a consistent pattern of significant increases in CP and IVTD of samples harvested in December over those of October and August. Significantly ($P < 0.05$) higher values for both were obtained in April and December than in either June or October. The NDF, ADF, and lignin progressively increased with harvest dates reaching their peaks in August before decreasing thereafter. Significantly ($P < 0.05$) lower values were obtained in April and December than in either June or October.

Herbage materials cut at the same stage of maturity on different harvest dates varied in chemical composition (table 2 and 3). Materials of the same age, and maturity class (vegetative, flower bud and full bloom stages) consistently maintained higher values of CP and IVTD in April or June, and December, and lowest values in August. In all cases, and for both CP and IVTD, the values were significantly ($P < 0.05$) higher in June than in October (**table 2**). For NDF, ADF and lignin, significantly lower values were obtained in April or June and December than in August or October (**table** 3).

DISCUSSION

The objective of this study was to

TABLE 1

The effects of dates of harvest on chemical composition of *Tridax procumbens* cut at same canopy age.

Date of harvest	Mean Stage	CP	IVTD	NDF	ADF	Fibre LIGNIN
		%				
			Herbage 28d days old			
April 29	1.8[b*]	22.7[a]	74.0[a]	36.0[b]	25.0[c]	2.2[d]
June 24	2.3[b]	20.0[b]	72.0[ab]	37.0[b]	29.2[b]	4.0[bc]
Aug. 19	3.0[a]	16.1[c]	65.0[c]	45.1[a]	36.6[a]	8.6[a]
Oct. 28	2.4[b]	.17.0[c]	80.0[ab]	38.3[b]	29.6[b]	5.3[b]
Dec. 9.	1.5[bc]	22.1[a]	75.0[a]	30.2[c]	20.3[cd]	2.4[d]
			Herbage 42 days old			
April 29	3.7[cd]	19.0[a]	65.0[a]	39.8[b]	32.5[b]	4.9[b]
June 24	4.6[b]	18.3[ab]	66.0[a]	48.3[a]	37.0[a]	7.2[a]
Aug. 19	5.7[a]	15.0[c]	56.0[c]	49.0[a]	38.6[a]	7.5[a]
Oct. 28	4.0[bc]	16.0[c]	60.0[ab]	42.5[b]	34.5[b]	7.0[a]
Dec. 9	2.6[d]	18.2[ab]	64.0[a]	41.4[b]	34.1[b]	5.4[b]
			Herbage 56 days old			
April 29	4.8[b]	18.8[a]	61.2[a]	55.5[ab]	37.5[ab]	6.5[bc]
June 24	6.4[a]	18.1[a]	63.0[a]	54.0[ab]	36.4[b]	7.8[a]
Aug. 19	7.0[a]	16.3[b]	51.0[c]	59.1[a]	42.4[a]	8.2[a]
Oct. 28	7.0[a]	16.5[b]	50.1[c]	58.0[a]	41.2[a]	8.6[a]
Dec. 9.	4.1[b]	17.8[a]	54.2[b]	47.0[c]	38.5[ab]	5.2[c]

**Means within columns and within herbage age classes followed by the same letter are not significantly different at the 0.05 probability level using Duncan's Multiple Range Test.*

determine the variations in chemical composition of *Tridax procumbens* across dates of harvest in a season. The measured parameters of CP IVTD, NDF, ADF and lignin were responsive to dates of harvest.

Tridax procumbens is an annual weed plant that regenerates profusely after shoot defoliation. The aftermath herbage could be got from canopies that grow through different months of the year. The months have well defined weather patterns especially rainfall and temperature. These variables are known to direct the physiological and developmental processes that control the elaboration of chemical constituents in plants (Van Soest, 1982). The plant integrates its environmental and physiological history and the cumulative effects are reflected in the stage of maturity reached at the time of harvest. In this study, canopies of *Tridax procumbens* reached significantly high mean stages in August at which period there was sufficient moisture supply, and high temperature which jointly promoted faster rate of maturity than in April or December. A faster rate of development would result in a higher rate of elaborations of structural materials which was reflected in increased fibre concentration during the warm and rainy months. Similarly, this resulted in decreased IVTD since fibre concentration correlates negatively with digestibility and crude protein concentration (Van Soest, 1982; Kalu and Fick, 1981, 1983). However levels of CP and IVTD and higher concentrations of fibre would

TABLE 2.

Seasonal changes in crude protein and *In vitro* true digestibility of *Tridax procumbens* cut at the same stage of development.

Date of Harvest		*Vegetative Stage*			*Flower bud Stage*			*Full bloom Stage*		
		*28**	*42*	*56*	*28*	*42*	*56*	*28*	*42*	*56*
					% CP					
April	29	23.5^{a}**	20.6^{a}	21.3^{a}	—	—	—	—	—	—
June	24	20.2^{ab}	18.2^{ab}	17.4^{b}	20.0^{a}	17.7^{a}	17.5^{a}	20.6^{a}	18.2^{a}	16.0^{a}
Aug.	19	15.4^{c}	14.9^{c}	14.2^{c}	14.7^{c}	14.4^{b}	13.6^{c}	15.1^{b}	14.0^{b}	14.0^{b}
Oct.	28	18.5^{b}	15.3^{c}	14.5^{c}	17.9^{b}	14.8^{b}	13.8^{b}	15.8^{b}	14.5^{b}	14.5^{b}
Dec.	9	22.8^{a}	19.8^{a}	19.2^{a}	21.6^{a}	18.4^{a}	16.3^{ab}	20.9^{a}	18.6^{a}	15.4^{ab}
					% IVTD					
April	29	83.5^{a}	80.3^{a}	78.5^{a}	78.5^{a}	—	—	—	—	—
June	24	75.1^{b}	70.0^{b}	65.3^{b}	74.0^{a}	68.0^{a}	63.5^{a}	73.2^{a}	70.5^{a}	65.0^{a}
Aug.	19	69.5^{bc}	60.5^{c}	57.7^{c}	69.0^{ab}	58.2^{b}	51.8^{b}	68.7^{ab}	58.0^{b}	50.3^{c}
Oct.	28	68.8^{bc}	61.2^{c}	57.2^{c}	68.3^{b}	60.1^{b}	51.0^{b}	68.2^{ab}	57.4^{b}	50.1^{c}
Dec.	9	73.0^{b}	68.4^{b}	63.8^{b}	71.5^{a}	65.3^{a}	62.4^{a}	70.4^{a}	63.6^{b}	60.5^{b}

* *Herbage age (in days) at harvest.*
** *Means followed by the same letter in the same column are not significantly different at 5% of Duncan's Multiple Range Test*

be expected in samples harvested in December. In this study, the contrary was observed. In December, moisture supply becomes a critical factor of the plant's survival, growth, and development. During this period, and with no irrigation, older shoots in the canopy either senesced prematurely or wilted and died. A sample therefore consisted of dead shoots, and dominating younger ones that developed from the base of the canopy. The presence of these young shoots would result in CP enrichment of the entire sample. Therefore, the exclusion of dead materials from the sample as was the procedure in this study, accounted for the high CP and IVTD and low fibre levels during the later part of the season.

The seasonal changes in mean stage values closely associated with the observed seasonal changes in chemical composition However, the degree of impression of these relationships was altered by age of canopy as well as the time of year of harvest. It appears that seasonal changes observed in *Tridax procumbens* were directed by seasonal environmental variations through their effects on stage of maturity. These findings and those reported earlier (Kalu *et **al.*** 1986), would provide useful guidelines in evaluating and deciding on butting management alternatives for effective and optimal utilization of the quality attributes of the plant.

With all the changes in chemical composition in response to dates of harvest, *Tridax procumbens* appears to have high potentials for use as livestock feed. However, before such a conclusion is made, more work is needed that would involve the collection and analysis of samples from a wider range of geographical locations and years, and backed up with trials using farm animals.

TABLE 3

Seasonal changes in Fibre concentration of *Tridax procumbens* cut at the same stage of development

Date of harvest		Vegetative Stage			Flower bud Stage			Full bloom Stage		
		20*	42	56	28	*42	42	28	42	56
					NDF					
April 29		35.3^{b**}	37.5^{b}	41.5^{c}						
April	29	35.3^{b**}	37.5^{b}	41.5^{c}	—	—	—	—	—	—
June	24	36.4^{b}	44.6^{a}	55.3^{ab}	35.3^{b}	45.1^{a}	48.5^{b}	35.0^{b}	48.6^{ab}	48.2^{b}
Aug.	19	40.0^{a}	45.4^{a}	58.9^{a}	43.8^{a}	46.8^{a}	59.6^{a}	44.1^{a}	50.5^{a}	55.8^{a}
Oct.	28	37.2^{ab}	43.8^{a}	58.4^{a}	44.0^{a}	44.9^{a}	60.1^{a}	43.8^{a}	50.0^{a}	56.3^{a}
Dec.	9	34.4^{b}	43.1^{a}	56.2^{ab}	35.8^{b}	46.4^{a}	46.8^{b}	36.0^{b}	47.0^{ab}	51.4^{ab}
					ADF					
April	29	26.3^{b}	29.5^{c}	38.8^{c}	—	—	—	—	—	—
June	24	27.2^{ab}	33.4^{ab}	43.4^{b}	28.5^{c}	34.1^{b}	38.1^{b}	28.0^{b}	36.4^{b}	38.9^{b}
Aug.	19	29.8^{a}	38.8^{a}	50.6^{a}	34.2^{ab}	39.3^{a}	41.8^{a}	30.2^{a}	41.6^{a}	53.3^{a}
Oct.	19	28.6^{a}	32.2^{ab}	48.5^{a}	35.6^{a}	38.4^{a}	42.0^{a}	30.8^{a}	41.8^{a}	54.8^{a}
Dec.	9	25.7^{b}	32.6^{ab}	44.3^{b}	27.9^{c}	34.7^{b}	36.5^{b}	26.9^{b}	34.9^{b}	38.6^{b}
					Lignin					
April	29	3.5^{c}	4.6^{c}	5.3^{c}	—	—	—	—	—	—
June	24	4.3^{b}	5.8^{b}	6.4^{b}	4.4^{b}	5.4^{b}	5.3^{b}	6.6^{b}	6.6^{b}	6.7^{b}
Aug.	19	6.8^{a}	7.9^{a}	7.3^{a}	6.5^{a}	7.5^{a}	7.6^{a}	6.8^{a}	9.3^{a}	8.3^{a}
Oct.	28	6.3^{a}	7.6^{a}	7.6^{a}	6.1^{a}	7.8^{a}	7.6^{a}	6.0^{a}	9.5^{a}	7.8^{a}
Dec.	9	4.1^{b}	5.0^{bc}	5.5^{c}	3.8^{b}	5.6^{b}	4.8^{b}	4.0^{b}	5.8^{b}	6.3^{b}

* *Herbage age (in days) at harves.*
** *Means followed by the same letter in the same column are not significantly different at 5% of Duncan's Multiple Range Test.*

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