NUTRITIONAL EVALUATION OF MAIZE FODDER AT TWO DIFFERENT VEGETATIVE STAGES

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Summary

Different fractions of maize plant and whole mixed fodder were analysed for their chemical composition and dry matter digestibility (DMD). Highest crude protein (CP) values were found in leaves as compared to the other portions. Younger plants contained more CP as compared to the matured ones. The crude fiber (CF) content of various fractions of the plant ranged between 19.12 to 35.60% with maximum values in the bottom portion of the stem. Matured plants contained more CF. The analysis of cell wall constituents indicated that the maximum values for neutral detergent fiber (NDF) were found in the bottom portion and in the whole mixed plant. The highest levels of acid detergent fiber (ADF) were observed in bottom fraction followed by whole mixed plant, whereas the other plant fractions did not show any differences. Variation in acid detergent lignin (ADL) values existed in different fractions of the plant and the lowest were in the top portion of the stem. Although there existed a variation in the mineral composition of different fractions of the plants, the results were non significant. Maximum DMD was found in leaves followed by the whole mixed plant, middle and bottom portion of the stem. The values of DMD were higher in younger plants as compared to the matured ones. It may be concluded that younger plants and the upper portion of the plants have a higher nutritive value as compared to the matured plants and lower portion of the plants.
(Key Words: Maize Fodder, Vegetative Stages)

Introduction

The production of good quality fodder and forage is of great importance for the development of livestock industry in the tropical countries as the productive performance of the animals is directly related to its availability. According to the recent estimates, 16-19% of the total cropped area in Pakistan i.e., 2.77 million hectares is put under fodder crops annually, which produces about 53 million tons of fodder biomass (NCA Report, 1988). The forage species grown in a locality are usually chosen for their climatic adaptation and seasonal dry matter production rather than for their chemical composition and nutritive value.

The quality aspects are evaluated in terms of voluntary intake, palatability, digestibility and nutrient utilization. The poor digestibility and lower voluntary intake are always associated with a relatively high lignin content which increases with the age and causes a corresponding decrease in the nutritive value. Variation in the contents of structural carbohydrates occurs with sensonal changes as well as at growth stage (Singh, 1976). The structural carbohydrate contents of fodder and forages are frequently measured to assess their nutritional value. Terry and Tilley (1964), Mowat et al. (1965) and Chenost et al. (1970) noticed that during the primary growth of lucerne in spring and early summer, the digestibility of the stem declined considerable as the crop became mature whereas the leaf fraction of crop was highly digestible at all the time. Dermarquilly and Jarrige (1974) and Wilman and Altimini (1984) reported that the leguminous leaves retained high digestibility and constant chemical composition as long as the leaves were green. On the other hand, the digestibility of the stem declined with age of maturity.

Maize is one of the most important plants grown for fodder production in Pakistan. The yield per hactare of maize fodder is about 30 tons. The annual green fodder production from maize is estimated to be about 0.84 million tons

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(Pakistan Economic Survey, 1982-83). Maize possesses most of the characteristics of an ideal type of foddder and forage plant. Very little data is however available on its chemical composition and nutritive value, especially on changes in different parts of the plant with the stage of growth/maturity. The present study was thus conducted to evaluate the nutritional value of different parts of the maize plant and to moniter the changes in these values with the maturity of the plant.

Materials and Methods

Two maize crops (variety-"Akbar") were sown in April and July, 1985 in the experimental fields of Animal Sciences Institute, NARC, Pakistan. Urea and diammonium phosphate (each 125 kg/ha) were applied as fertilizers. The fields were irrigated 5 times during the experimental period. The overall fodder yield of green biomass was 37.5 tons (fresh weight). The representative samples of fodder were harvested from different places of the experimental field on monthly basis.

The leaves (leaf blade + leaf sheath) were separated manually from the whole plant and the stem was then divided into three equal portions (top, middle and bottom). The whole plant and the individual fractions were chopped (2~3cm), dried at 60°C and the grounded samples were then analysed for the proximate chemical composition (AOAC, 1984). The cell wall constituents i.e., NDF, ADF, cellulose, hemicellulose, lignin and tannins were determined by the methods as described by Goering and Van Soest (1970). The in-situ dry matter digestibility was determined using the nylon bag technique as described by Orskov et al. (1980). 2 g of grounded sample was put into the nylon bags (4" x 2.5") of dacron cloth pore size 40 u. The bags were suspended in the ventral sac of rumen of fistulated buffalo calf maintained on roughage based ration. After the incubation period (48 hours) the suspended bags were taken out, washed with running tap water and dried at 60°C. Digestibility or dry matter loss was calculated by the difference between the initial and final weights of the bag contents. The samples were also analysed for the mineral contents, sodium (Na), potassium (K), calcium (Ca) and phosphorus (P) according to the methods described in Agri. Hand Book-60, USDA (1954). The data was subjected to statistical analysis using ANOVA and least square means as described by Steel and Torrie (1960).

Results and Discussion

The proximate composition and cell wall constituents of different fractions of two maize crops are shown in tables 1-6. The results indicated that the dry matter content of all the fractions i.e., whole plant, leaves and portions of the stem increased significantly with the stage of maturity. The maximum dry matter content was found in top portion of the stem followed by leaves. There was no significant difference in the middle, bottom and whole plant fractions. As the plant grows the photosynthetic activity increases leading towards higher biomass production. This explains the results obtained as the maximum dry matter content was found in the top portion of the stem followed by leaves.

The crude protein content of various fractions of the plant reduced significantly with the age of the plant reduced significantly with the age of maturity. The crude protein content of the whole plant reduced to about 30% at the age of two months whereas after three months of sowing the overall reduction was about 66%. The maximum CP values were found in the leaves fraction. Although there was a significant reduction in the CP content of the leaves with the stage of growth, however, it was less pronounced as compared to other fractions of the plant. The lowest values of the CP were found in the stem fraction of the plant (table 6). Studies carried out by other workers have shown that the crude protein content of forages normally declined with the age of maturity. Wilman and Altimini (1984) and Aman (1985) reported that the leaf fraction of red clover contained 2-3 times more CP than the stem fractions. Banda and Valdez (1976) and Chung et al. (1985) reported similar results in sugarcane and Korean native reed. They observed that CP content was higher during the early growth and decreased with maturity.

The crude fiber content of various parts of the maize plant ranged between 18.35 to 42.33%. Maximum crude fiber concentration was found in the bottom portion of the plant (34.29 ± 3.59%) followed by whole plant mixed fraction 27.86 ± 3.14%, table 6). Slightly lower values were found

in leaves and top indicating that the soft portions of the plant contained less fiber. It may be inversely correlated with their higher crude protein content, digestibility and nutritive value of these fractions. Maturity affects the CF content of the plants. The matured plant contained more CF as compared to the younger plants. Seasonal variations (hot season) also affected the CF content. The results showed that the crop sown in April and harvested in the months of June and July showed higher CF content as compared to that sown in July and harvested in August, September and October. There was no appreciable difference in either extract values of different fractions of the plants. The data however, indicated and increasing trend with the maturity of plant (table 1-5). Higher levels of ash were found in the leaves followed by the top and mixed fodder fractions (table 6). The data also demonstrated that the higher values of ash were found with the increasing degree of maturity of plants although the results were nonsignificant.

Results of cell wall constituents showed that the NDF values of bottom and whole mixed plant fractions were maximum followed by leaves and top portion of the stem. The values for ADF also showed similar trends and were maximum (38.12 ± 2.44%) in the bottom portion followed by whole mixed plant fraction (34.86 ± 1.25%). There was no significant difference in the ADF values of the other fractions of the plant. The cellulose content was found to be maximum in the bottom portion of the stem 32.24 ± 2.33% followed by whole plant mixed fodder fractions 28.43 ± 1.21% (table 6). The other fractions of the plant, leaves, top and middle portion of the stem did not show any significant difference. In the case of hemicellulose, the maximum values were observed in leaves and the minimum values in the bottom fraction observed in leaves and the minimum values in the bottom fraction of the stem, the differences being statistically significant. There were no significant differences in the hemicellulose values of other fractions of the plant. Although the data on the cell wall constituents showed some variations, it indicated that both the values for cellulose and hemicellulose showed a decreasing trend. Variation in the mean values of ADL existed in the different fractions of the plants. This variation may be due to different stages of plant maturity and / or environmental effects. The lowest value of ADL was found in the middle portion of the stem as compared to the other parts. Significant differences were observed in the values of tannins in different fractions of the plant. The maximum values were found in the bottom portion of the stem. The top portion of the stem indicated the minimum values. The whole plant mixed fodder showed on the average 8.71 ± 1.02% of tannins (table 6). The data indicated that the softness of the plant fraction is associated with tannins which act as palatablity, digestibility and intake depressant. The leaves and top portion of the stem with minimum tannin content are more acceptable to the animals as compared to other fractions of the plant.

The data on the mineral composition of different fractions of maize plant is shown in table 7. The results indicated that although there existed a variation in the mineral composition of different fractions of plant the results were nonsignificant. Similarly the stage of maturity had little effect on the mineral composition of plant fraction as evident from these results. The Ca and P contents of two maize varieties Ganga-5 and Vijay has been reported to be 0.65, 0.47 and 0.14, 0.15% respectively (Singh, 1976). These values are close to the values observed in this study. The mineral elements constitute about 10% of the forage dry matter. The main factors affecting the mineral composition of forages are genus, species, variety, stage of maturity, soil and environmental factors. Sen and Ray (1964) studied the Ca and P levels in some tropical grasses as different stages of maturity. They reported that a great diversity exists between the patterns revealed by different elements in different plant species at various stages of maturity. This is probably due to variation in mineral composition of different plant organs. As the plant matures the ratios of these different organs to one another changes radically.

In situ dry matter digestibility (DMD) of different parts of the maize plant indicated that the maximum DMD was found in leaves followed by the whole plant mixed fodder and middle portion of the stem (table 6). The lowest value of DMD was found in the bottom portion of the stem. Results also demonstrated that the values of DMD were higher in younger plants as compared to mature ones (table 1-5). The crude protein and crude fiber contents in different plant frac-

TABLE 1. CHEMICAL COMPOSITION AND IN SITU DRY MATTER DIGESTIBILITY (DMD) OF LEAVES OF TWO MAIZE CROPS AT DIFFERENT STAGES OF MATURITY (% DM)

Parameters	Crop I		Crop II		
Harvest time (month)	June	July	August	September	October
Proximate composition					
Dry matter (DM)	30.23 ± 0.29^{a}	38.83 ± 0.296^{b}	27.53 ± 0.400^{c}	28.91 ± 0.193^{c}	36.65 ± 0.977^{b}
Crude protein (CP)	10.35 ± 0.015^{a}	7.65 ± 0.028^{b}	20.59 ± 0.065^{c}	14.85 ± 0.036^{c}	12.53 ± 0.018^{c}
Crude fiber (CF)	28.50 ± 0.220^{a}	35.60 ± 0.235^{b}	18.35 ± 0.112^{c}	19.13 ± 0.176^{c}	19.54 ± 0.437^{c}
Ether extract (EE)	0.75 ± 0.069	2.17 ± 0.316	0.35 ± 0.060	1.17 ± 0.096	1.44 ± 0.092
Ash	8.88 ± 0.082	10.26 ± 0.319	5.73 ± 0.104	8.98 ± 0.109	10.94 ± 0.61
Cell wall constituents					
Acid detergent fiber (ADF)	34.04 ± 0.076^{a}	34.60 ± 0.31^{a}	25.68 ± 0.239^{b}	32.55 ± 0.275^{c}	32.42 ± 0.289^{c}
Neutral detergent fiber (NDF)	59.40 ± 0.382^{a}	61.52 ± 0.252^{b}	53.73 ± 0.169^{c}	57.28 ± 0.120^{d}	57.88 ± 0.111^{d}
Hemicellulose (H-CHO)	25.40 ± 0.305	26.92 ± 0.163	28.05 ± 0.116	24.73 ± 0.262	25.46 ± 0.235
Cellulose (CHO)	27.38 ± 0.234	28.82 ± 0.185	20.95 ± 0.237	22.33 ± 0.144	26.17 ± 0.102
Acid detergent lignin (ADL)	5.68 ± 0.078^{a}	6.66 ± 0.088^{b}	4.72 ± 0.066^{c}	6.17 ± 0.245^{d}	10.08 ± 0.104^{e}
Tannins	2.54 ± 0.031^{a}	4.48 ± 0.111^{b}	3.11 ± 0.060^{c}	4.08 ± 0.109^{d}	6.86 ± 0.027^{e}
DMD	64.09 ± 2.19^{aa}	60.02 ± 1.65^{b}	69.13 ± 0.91^{c}	55.43 ± 0.95^{d}	38.72 ± 1.48^{e}

^{a,b,c,d,e}means in the same row without a common letter in their superscript differ ($P < 0.05$).

TABLE 2. CHEMICAL COMPOSITION AND DMD OF TOP FRACTIONS OF THE STEM OF MAIZE PLANT HARVESTED AT DIFFERENT STAGES OF MATURITY (% DM)

Parameters	Crop I		Crop II		
Harvest time (month)	June	July	August	September	October
Proximate composition					
DM	36.70 ± 0.097^{a}	46.83 ± 0.174^{b}	20.52 ± 0.208^{c}	28.42 ± 0.295^{d}	40.39 ± 0.175^{e}
CP	12.80 ± 0.407^{a}	9.29 ± 0.116^{b}	19.50 ± 0.274^{c}	11.66 ± 0.345^{a}	7.10 ± 0.376^{d}
CF	24.90 ± 0.116^{a}	35.60 ± 0.115^{b}	20.71 ± 0.449^{c}	21.27 ± 0.338^{c}	24.84 ± 0.043^{a}
EE	0.45 ± 0.076	1.55 ± 0.087	0.60 ± 0.058	1.07 ± 0.097	1.35 ± 0.059
Ash	6.00 ± 0.603	10.03 ± 0.196	4.68 ± 0.196	5.77 ± 0.127	6.68 ± 0.187
Cell wall constituents					
ADF	28.28 ± 0.351^{a}	31.19 ± 0.113^{b}	31.53 ± 0.137^{b}	32.09 ± 0.094^{c}	33.66 ± 0.382^{d}
NDF	49.40 ± 0.280^{a}	55.34 ± 0.174^{b}	57.89 ± 0.480^{c}	60.39 ± 0.088^{d}	58.50 ± 0.115^{c}
H-CHO	21.12 ± 0.427	24.15 ± 0.161	26.37 ± 0.213	28.29 ± 0.214	24.82 ± 0.274
CHO	21.67 ± 0.432	26.78 ± 0.185	26.60 ± 0.319	25.12 ± 0.116	25.71 ± 0.283
ADL	4.43 ± 0.105^{a}	6.61 ± 0.129^{b}	4.90 ± 0.087^{c}	4.96 ± 0.075^{c}	6.56 ± 0.112^{b}
Tannins	3.06 ± 0.072^{a}	3.69 ± 0.048^{b}	2.04 ± 0.130^{c}	2.93 ± 0.139^{d}	3.57 ± 0.048^{b}
DMD	59.28 ± 2.35^{a}	51.56 ± 1.97^{b}	72.0 ± 1.96^{c}	49.21 ± 2.44^{b}	38.55 ± 1.96^{d}

^{a,b,c,d,e}means in the same row without a common letter in their superscript differ ($P < 0.05$).

TABLE 3. CHEMICAL COMPOSITION AND DMD OF MIDDLE PORTION OF THE STEM OF MAIZE PLANT OF DIFFERENT STAGES OF MATURITY (% DM)

Parameters	Crop I				Crop II			
Harvest time (month)	June		July		September		October	
Proximate composition								
DM	19.20	0.411[a]	25.14	0.216[b]	18.86	0.474[a]	39.69	0.078[c]
CP	2.71	0.049[a]	3.55	0.150[b]	6.74	0.081[c]	6.72	0.096[c]
CF	27.30	0.095[a]	34.90	0.050[b]	20.88	0.088[c]	26.07	0.079[a]
EE	0.55	0.031	2.17	0.059	1.00	0.088	1.31	0.032
Ash	3.30	0.120	7.40	0.231	3.70	0.076	4.19	0.058
Cell wall constituents								
ADF	29.77	0.374[a]	30.99	0.090[a]	32.82	0.261[b]	31.03	0.976[b]
NDF	56.28	0.288[a]	59.35	0.298[b]	55.60	0.464[a]	52.48	0.302[c]
H-CHO	27.00	0.026	28.36	0.106	21.78	0.056	22.45	0.113
CHO	24.03	0.042	27.56	0.239	27.74	0.080	23.80	0.044
ADL	3.34	0.037[a]	4.52	0.061[b]	4.91	0.058[b]	6.00	0.045[c]
Tannins	3.08	0.012[a]	6.64	0.253[b]	2.06	0.006[c]	6.37	0.037[b]
DMD	59.07	1.78[a]	61.66	0.95[b]	52.86	1.27[c]	48.73	2.08[d]

[a,b,c,d]means in the same row without a common letter in their superscript differ ($P < 0.05$).

TABLE 4. CHEMICAL COMPOSITION AND DMD OF BOTTOM PORTION OF STEM OF THE MAIZE PLANT HARVESTED AT DIFFERENT STAGES OF MATURITY (% DM)

Parameters	Crop I		Crop II	
Harvest time (month)	June	July	September	October
Proximate composition				
DM	18.10 ± 0.110[a]	26.34 ± 0.077[b]	23.63 ± 0.069[c]	31.50 ± 0.109[d]
CP	2.42 + 0.021[a]	3.55 + 0.076[b]	4.10 ± 0.076[c]	5.65 ± 0.029[d]
CF	29.65 ± 0.534[a]	40.50 ± 0.838[b]	24.67 + 0.26[c]	42.33 ± 0.937[b]
EE	0.28 ± 0.009	1.30 ± 0.023	1.00 ± 0.006	1.27 ± 0.025
Ash	3.60 ± 0.053	9.52 + 0.111	3.55 ± 0.009	4.77 ± 0.036
Cell wall constituents				
ADF	40.33 ± 0.936[a]	32.32 + 0.862[b]	43.60 ± 0.623[c]	36.46 ± 0.618[d]
NDF	62.54 ± 1.450[a]	54.99 ± 0.629[b]	62.72 + 0.903[a]	53 11 + 0.726[b]
H-CHO	19.21 ± 0.092	22.66 ± 0.086	19.12 ± 0.109	16.65 ± 0.087
CHO	28.40 ± 0.207	36.70 ± 0.432	28 02 ± 0.263	35.82 ± 0.532
ADL	3.88 ± 0.061[a]	6.63 ± 0.104[b]	6.16 ± 0.496[b]	8.43 ± 0.213[c]
Tannins	5.60 ± 0.076[a]	11.25 ± 0.231[b]	17.11 ± 0.168[c]	19.49 ± 0.204[d]
DMD	50.61 ± 1.65[a]	51.72 ± 1.39[a]	34.42 ± 0.98[b]	41.28 ± 0.99[c]

[a,b,c,d]means in the same row without a common letter in their superscript differ ($P < 0.05$).

TABLE 5. CHEMICAL COMPOSITION AND DMD OF TOP FRACTIONS OF THE STEM OF MAIZE PLANT HARVESTED AT DIFFERENT STAGES OF MATURITY (% DM)

Parameters	Crop I		Crop II		
Harvest time (month)	June	July	August	September	October
Proximate composition					
DM	19.10 ± 0.027[a]	27.94 ± 0.732[b]	23.55 ± 0.225[c]	29.91 ± 0.052[a]	31.31 ± 0.158[c]
CP	11.25 ± 0.043[a]	6.56 ± 0.026[b]	20.07 ± 0.570[c]	14.44 ± 0.317[d]	6.74 ± 0.076[b]
CF	29.10 ± 0.069[a]	37.93 ± 0.496[b]	20.83 ± 0.653[c]	25.08 ± 0.268[d]	26.38 ± 0.952[d]
EE	0.45 ± 0.005	2.30 ± 0.006	0.54 ± 0.007	1.22 ± 0.166	1.28 ± 0.006
Ash	5.24 ± 0.012	9.02 ± 0.131	5.22 ± 0.029	6.07 ± 0.070	6.75 ± 0.125
Cell wall constituents					
ADF	37.25 ± 0.962[a]	36.39 ± 0.632[a]	30.46 ± 0.188[b]	36.51 ± 0.183[a]	33.71 ± 0.320[c]
NDF	59.59 ± 0.837[a]	60.03 ± 0.867[a]	55.10 ± 0.159[b]	59.42 ± 0.064[c]	56.46 ± 0.538[b]
H-CHO	22.21 ± 0.673	24.64 ± 0.731	24.64 ± 0.129	22.91 ± 0.078	22.75 ± 0.393
CHO	30.15 ± 0.067	31.20 ± 0.092	25.10 ± 0.137	29.65 ± 0.315	31.97 ± 0.296
ADL	7.07 ± 0.023[a]	8.59 ± 0.034[b]	5.25 ± 0.076[c]	6.53 ± 0.252[d]	7.73 ± 0.093[e]
Tannins	9.44 ± 0.019[a]	10.94 ± 0.023[b]	2.29 ± 0.037[c]	8.06 ± 0.276[d]	12.82 ± 0.293[c]
DMD	61.68 ± 1.47[a]	57.16 ± 1.27[b]	73.36 ± 1.48[c]	43.35 ± 0.33[d]	39.69 ± 1.05[e]

[a,b,c,d,e]means in the same row without a common letter in their superscript differ ($P < 0.05$)

TABLE 6. PROXIMATE COMPOSITION, CELL WALL CONSTITUENTS AND IN SITU DMD OF DIFFERENT PARTS OF THE MAIZE PLANTS (% DM)

Parameters	Leaves	Stem Fractions			Whole mixed plant
		Top	Middle	Bottom	
Proximate composition					
DM	32.43 ± 2.42[a]	34.57 ± 2.84[b]	24.22 ± 3.47[c]	24.89 ± 2.79[c]	26.36 ± 2.97[c]
CP	13.19 ± 2.19[a]	12.07 ± 1.27[a]	4.93 ± 1.05[a]	3.93 ± 1.26[a]	11.81 ± 2.46[a]
CF	24.22 ± 3.42[a]	25.90 ± 3.33[a]	27.54 ± 3.28[b]	34.29 ± 3.59[c]	27.86 ± 3.14[b]
EE	1.17 ± 0.28	1.00 ± 0.09	1.26 ± 0.34	0.96 ± 0.19	1.16 ± 0.19
Ash	8.96 ± 0.89[a]	6.63 ± 1.23[b]	4.63 ± 0.94[c]	5.36 ± 1.13[d]	6.46 ± 0.67[b]
Cell wall constituents					
ADF	31.86 ± 1.60[a]	31.35 ± 0.72[a]	31.15 ± 0.43[a]	38.18 ± 2.44[b]	34.86 ± 1.25[c]
NDF	47.96 ± 1.29[a]	56.31 ± 2.42[a]	56.33 ± 2.51[a]	58.34 ± 2.51[a]	58.10 ± 0.97[a]
H-CHO	26.11 ± 0.60[a]	25.73 ± 1.93[a]	24.89 ± 1.58[a]	19.41 ± 1.24[b]	23.23 ± 0.42[c]
CHO	25.13 ± 1.50[a]	25.17 ± 1.10[a]	25.43 ± 0.91[a]	32.24 ± 2.33[b]	29.61 ± 1.21[c]
ADL	6.66 ± 0.91[a]	5.49 ± 0.54[b]	4.71 ± 0.53[c]	6.28 ± 1.02[a]	7.03 ± 0.46[d]
Tannins	4.21 ± 0.42[a]	3.05 ± 0.51[b]	4.54 ± 1.29[a]	13.36 ± 2.34[c]	8.71 ± 1.02[d]
DMD	57.48 ± 2.20[a]	54.14 ± 1.58[b]	55.57 ± 1.94[a]	44.51 ± 4.09[c]	55.05 ± 1.15[d]

[a,b,c,d]means in the same row without a common letter in their superscript differ ($P < 0.05$).

TABLE 7. MINERAL COMPOSITION OF DIFFERENT FRACTIONS OF THE MAIZE PLANTS AT DIFFERENT STAGES OF MATURITY (% DM)

Parameters	Crop I		Crop II		
Harvest time (month)	June	July	August	September	October
Leaves					
Sodium (Na)	0.7 ±0.005	0.66± 0.032	0.20± 0.013	0.29± 0.026	0.20± 0.020
Potassium (K)	1.07 ±0.012	0.72± 0.023	2.80± 0.062	2.93± 0.057	3.35± 0.068
Calcium (Ca)	0.67 ±0.022	0.89± 0.041	0.38+ 0.041	1.23± 0.014	0.68± 0.037
Phosphorus (P)	0.30 +0.001	0.04± 0.001	0.04± 0.002	0.06± 0.002	0.05± 0.004
Fraction of the stem*					
Top					
Na	0.20 ±0.002	0.80± 0.050	0.20± 0.002	1.42± 0.120	0.14± 0.004
K	1.00 ±0.010	0.55± 0.025	2.50± 0.108	2.87± 0.368	2.55± 0.571
Ca	0.25 ±0.036	0.51± 0.091	0.44+ 0.006	0.70± 0.051	0.55± 0.026
P	0.06 ±0.002	0.03± 0.001	0.03± 0.007	0.05± 0.003	0.05± 0.004
Middle					
Na	0.55 ±0.021	1.00± 0.060	–	0.67± 0.055	0.10± 0.001
K	1.18 +0.063	0.50± 0.004	–	2.28± 0.453	2.38± 0.263
Ca	0.51 ±0.005		–	0.72± 0.056	0.52± 0.009
P	0.05 ±0.001	0.02± 0.001	–	0.05± 0.001	0.04± 0.002
Bottom					
Na	0.45 ±0.062	0.70± 0.046		0.90+ 0.026	0.15± 0.003
K	1.60 ±0.131	0.25± 0.005	–	2.33± 0.139	2.40± 0.107
Ca	0.43 ±0.029	0.40± 0.012	–	1.24± 0.046	0.42± 0.006
P	0.04 ±0.004	0.01± 0.001		0.06± 0.001	0.04± 0.002
Whole mixed plant					
Na	0.63 ±0.115	0.83± 0.023	0.20± 0.048	1.15± 0.291	0.10± 0.005
K	1.18 ±0.012	0.60± 0.045	2.93± 0.354	2.93± 0.732	2.65± 0.097
Ca	0.67 ±0.032	0.59± 0.023	1.23± 0.602	1.32± 0.343	0.91+ 0.023
P	0.08 ±0.008	0.08± 0.001	0.07± 0.006	0.05± 0.002	0.03± 0.004

*Whole stem without leaves.

tion at various stages of maturity correlates well with the digestibility values. Similarly the tannin content of plant seems to have a good correlation with the digestibility of green fodder. From these results it may be concluded that young maize plants and upper portion of the plants have higher nutritional value as compared to the matured plants.

Literature Cited

Aman, P. 1985. Chemical composition and in vitro degradability of major chemical constituents in botanical fractions of red clover harvested at different stages of maturity. J. Sci. Food Agric. 36:775-789.

A.O.A.C. 1984. Official methods of analysis (14th ed). Association of Official Analytical Chemists, Washington, D.C.

Banda, M. and R. E. Valdez. 1976. Effect of stage of maturity on nutritive value of sugar cane. Tropical Animal Production. 1(2):94-97.

Chenost, M., E. Grenet, C. Demarquilly and R. Jarrige. 1970. The use of the nylon bag technique for the study of forage digestion in the rumen and for predicting feed value. Proc. XIth Int. Grassland Congr., Surfers Paradise. pp.697-701.

Chung, W. B., J. W. Park, C. Yoon, I. S. Cho, K. H. Kim and S. H. Ro. 1985. Seasonal changes of chemical composition and dry matter digestibility of Korean native reed(*Phragmites longivalvis*) stendel (Communis Trinus). In Procedings the 3rd AAAP Animal Science Congress. Vol. 2. Seoul, Korea. pp.961-962.

Demarquilly, C. and R. Jarrige. 1974. The comparative nutritive value of grasses and legumes. Proc. 5th General Meeting, European Grassland Federation 1973, Uppsala, Vaxtodling 1974, 28:33-41.

Goering, H. K. and P. J. Van Soest. 1970. Forage fiber analyses. USDA, ARS, Agri. Hand Book No. 379.

Mcwat, D. N., R. S. Fulkerson, W. E. Tossell and J. E. Winch. 1965. The in-vitro digestibility and protein content of leaf and stem portions of forages. Can J. Plant Sci. 45:321-331.

NCA. 1988. A report of national commission on agriculture. Govt. of Pakistan. Ministry of Food Agriculture and Cooperatives, Islamabad.

Orskev, E. R., F. D. Dc B. Hovell and F. Mould. 1980. The use of the nylon bag technique for the evalua tion of feedstuffs. Tropical Animal Prod. 5:193 213.

Pakistan Economic Survey. 1982-83. Govt of Pakistan, Economic Advisers Wing, Finance Division, Islamabad

Sen, K. C. and S. N. Ray. 1964. Nutritive value of Indian cattle feeds. Tech. Bull. 25. Indian Coun. Agric. Res. New Delhi.

Singh, R. 1976. Voluntary intake, digestibility and efficiency of utilization as influenced by compositional factors. In Proceedings: Forage quality evaluation and processing techniques for increased animal productivity (Ed. Pradhan, K. and S. S. Khirwar). pp.153 155.

Steel, R.G.D. and J. H. Torrie. 1980. Principles and Procedures of Statistics. McGraw-Hill Book Co., New York, N. Y.

Terry, R. A. and J.M.A. Tilley. 1964. The digestability of the leaves and stems of perennial ryegrass, cocksfoot, timothy, tall fescue, lucerne and sainfoin, as measured by an in-vitro procedure. J. Br. Grassl Soc. 19:363-372.

Wilman, D. and M.A.K. Altimimi. 1984. The in-vitro digestibility and chemical composition of plant parts in white clover, red clover and lucerne during primary growth. J. Sci. Food Agric. 35:133-138.