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FODDER QUALITY OF VARIOUS GRASSES AND LEGUMES AT DIFFERENT GROWTH STAGES

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SUMMARY

The present experiment was carried out to evaluate the proximate composition and fodder quality of various grasses and legumes at different growth stages. Among the four grasses evaluated for proximate principles, Marvel recorded the highest per cent, nitrogen free extract, ether extract, total minerals and the lowest crude fibre content. It also recorded the highest per cent dry matter, *in vitro* dry matter digestibility, Ca, Mg and Zn with the lowest, neutral detergent fibre, acid detergent fibre and lignin content. Madras anjan grass recorded the highest crude protein content. Among the four legumes evaluated *Stylosanthus seabrana* recorded the highest per cent crude protein, nitrogen free extract and ether extract with lowest crude fibre content. It also recorded highest per cent dry matter, *in vitro* dry matter digestibility, Ca, Mg and Zn with the lowest neutral detergent fibre, acid detergent fibre and lignin. Ran mung or Siratro was the highest in total minerals than other legumes. As regard to growth stages, the per cent dry matter, crude fibre, ether extract, neutral detergent fibre, acid detergent fibre and lignin in grasses as well as legumes were increased with the advancement of growth stages. The crude protein, total minerals, Ca, Mg and Zn and *in vitro* dry matter digestibility were declined with advancement of growth stages. Among the growth stages studied, forage quality of all fodder grasses and legumes at pre flowering stage was much higher, followed by 50 per cent and post flowering stages.

Key words: Forage grasses and legumes, proximate composition, growth stages

In India, livestock plays a vital role in sustainable livelihood, nutritional and environmental security and growth of agriculture. Livestock contributes a major role in generating cash income through the production of milk, butter, meat, egg, hides, skin, wool and manure (Dhungana *et al.*, 2012). The current status of the deficit of green and dry fodder were 63.50 and 23.56 per cent, respectively in India and the projected deficit of CP and TDN were 45.76 and 33.71 million tones analyzed at 2015 (IGFRI, 2013). A multiplicity of factors affects the rate of change in nutrient composition with advancing plant development and maturity stages. These factors may include any one or a combination of the following: plant type, climate, season, weather, soil type and fertility, soil moisture, leaf stem ratio, physiological and morphological characteristics and others, and may vary with annuals vs. perennials, grasses vs. legumes, etc. Therefore, present study was carried out to evaluate the fodder quality and proximate composition of some of the grasses and legumes forages at different growth stages. This study will be helpful to recommend proper stage of harvesting for higher nutritive value in selected forage crops.

MATERIAL AND METHODS

Four grasses *viz.*, Marvel (*Dichanthium annulatum*) (Forssk.) Staf, Dongari grass (*Crysopogan fulvus*) (Spreng) Chiov, Madras anjan (*Cenchrus ciliaris* L.), and Pawana (*Sehima nervosum*) (Rottler) Stapf and four forage legumes *viz.*, Stylo (*Stylosanthus seabrana*) B.L. Maass & t Mannatje, Stylo (*Stylosanthus hamata* L.) Taub, Hedge lucerne or Dashrath grass (*Desmanthus virgatus* L.) and Ran mung or Siratro (*Macroptilium atropurpureum*) (DC.) Urb were grown at Grass Breeding scheme, MPKV, Rahuri. These fodder crops were collected during *Kharif*-2019.

The representative forage samples at different growth stages *viz.*, at pre-flowering, 50 % flowering and post flowering stages collected were and oven dried until constant weight to calculate per cent dry matter (DM). The dried plant samples were ground to pass through 1 mm sieve used for estimation of all

proximate and forage quality parameters. The samples were analyzed for proximate composition (AOAC, 1990) and nitrogen free extract was calculated by difference. Forage quality parameters *viz.,* acid detergent fibre (ADF), neutral detergent fibre (NDF) (Van Soest *et al.,*1991), lignin (Hussain *et al*., 2002) and *in-vitro* DM digestibility (IVDMD) using goat rumen liquor (Tilley and Terry, 1963). The minerals *viz.,* calcium, magnesium and zinc were determined on atomic absorption spectrophotometer after diacid digestion of plant sample.

RESULTS AND DISCUSSION

The proximate composition of forage grasses and legumes at different growth stages depicted in Table 1.

Crude protein

The mean crude protein (CP) per cent was recorded higher in legumes (13.5%) than grasses (6.64%) fodder crops investigated. Among the legumes studied, *Stylosanthes seabrana* recorded the highest mean per cent CP (15.5%), whereas among the fodder grasses, Madras anjan recorded the highest mean per cent CP (7.37 %) of three growth stages. Among the all fodder crops, Dashrath grass recorded the highest CP of 17.9% at pre flowering stage. The per cent CP was decreased with the advancement of growth stages in both grasses and legumes i.e. higher CP at pre flowering, followed by 50% flowering and lower at post flowering stage.

The values reported are in agreement with the literature values. The CP content in Marvel at early bloom and maturity stage were 6.4 and 4.3 per cent, respectively (Sultan *et al*., 2008). Sultan *et al*. (2007) reported CP content decreased with maturity stage of grasses, it was 5.4% at maturity stage and 8.7% at early bloom stage in Madras anjan. Kumar *et al.* (2016) reported that CP content in Madras anjan, Marvel and *Stylosanthes hamata* were 6.80, 6.50 and 15.78 per cent, respectively.

Crude fibre

The grasses were higher in crude fibre content (CF) than legume fodder crops. The crude fibre was increased with the advancement of growth stages. It was observed that, mean per cent CF was the lowest in legumes (28.8%) than grasses (31.2%). Among the legumes, *Stylosanthes seabrana* recorded the lowest mean per cent CF (25.2%), whereas among the grasses, Marvel recorded the lowest mean CF (27.4%) content of three growth stages. Among the fodder crops studied, *Stylosanthes seabrana* recorded the lowest CF (23.4%) at pre flowering stage. Jayprakash *et al*. (2016) reported CF content in Dashrath grass *Stylosanthes hamata* was 22.50 and 25.28 per cent, respectively. Ahmed and Ahmed (2015) reported 34.66 per cent CF in Ran mung or Siratro.

Nitrogen free extract

It was observed that, mean per cent nitrogen free extract (NFE) was slightly higher in grasses (50.5%) than legumes (49.4%). Within grasses, Marvel recorded the highest mean per cent NFE (53.2%), whereas among the legumes, *Stylosanthes seabrana* recorded the highest mean per cent NFE (52.2%) of all growth stages. Nitrogen free extract was increased at 50% flowering and thereafter it was slightly decreased with the advancement of growth stage in both grasses and legumes forages. Among the fodder crops, Marvel recorded highest NFE (54.6%) at pre flowering stage.

Ether extract

It was observed that, mean per cent ether extract (EE) was the higher in legumes (1.60%) than grasses (0.93%). Among the grasses, Marvel recorded the highest mean per cent EE (1.12%), while, among the legumes, *Stylosanthes seabrana* recorded the highest mean per cent EE (1.90%) of three growth stages. It was found that per cent EE increased with the advancement of growth stages in both grasses and legumes forages. Among the fodder crops, *Stylosanthes seabrana* recorded the highest per cent EE (2.01%) at post flowering stage. Jayprakash *et al*. (2016) that EE in Hedge lucerne and Stylo (*Stylosanthes hamata* L.) was 2.29 and 2.53 per cent, respectively. Ahmed and Ahmed (2015) found 2 % EE in Ran mung.

Total minerals

The grasses were recorded higher mean total mineral content (10.7%) than forage legumes (6.7%). The total mineral content at pre flowering stage was higher and declined towards the maturity of crop. Marvel recorded the highest mean total mineral content of 11.7 per cent while, Ran mung recorded the highest

Table 1. Proximate composition of forage grasses and legumes at different growth stages

S. No.	Name of crop	Crude protein (%)				Crude fibre (%)				Nitrogen Free Extract (%)				Ether extract (%)				Total minerals (%)			
		I	II	III	Mean	I	II	III	Mean	I	II	III	Mean	I	II	III	Mean	I	II	III	Mean
	Grasses																				
1.	*Dichanthium annulatum*	7.22	7.66	4.94	6.60	24.5	27.1	30.8	27.4	54.6	52.9	51.9	53.2	0.83	1.20	1.33	1.12	12.9	11.1	11.0	11.7
2.	*Crysopogan fulvus*	9.84	5.25	4.38	6.49	30.7	32.8	35.7	33.1	46.5	51.1	49.7	49.1	0.80	0.98	1.05	0.95	12.2	9.9	9.2	10.4
3.	*Cenchrus ciliaris*	10.7	6.56	4.81	7.37	29.2	31.9	34.4	31.8	45.9	50.8	50.7	49.2	0.69	0.87	0.93	0.83	13.5	9.9	9.2	10.8
4.	*Sehima nervosum*	8.31	5.25	4.81	6.12	30.8	32.2	35.0	32.7	49.1	51.6	50.5	50.3	0.63	0.89	1.06	0.86	11.2	10.1	8.6	10.0
	Mean	9.02	6.18	4.73	6.64	28.8	31.0	33.9	31.2	49.1	51.6	50.8	50.5	0.73	0.98	1.09	0.93	12.4	10.2	9.5	10.7
	Legumes																				
5.	*Stylosanthes seabrana*	16.8	15.7	14.0	15.5	23.4	25.1	27.1	25.2	49.2	49.8	51.3	50.1	1.72	1.97	2.01	1.90	8.9	7.4	5.6	7.3
6.	*Stylosanthes hamata*	14.0	12.0	10.0	12.0	25.4	28.2	31.0	28.2	51.8	52.8	52.0	52.2	1.23	1.73	1.46	1.47	7.6	5.2	5.5	6.1
7.	*Deshmanthus virgatus*	17.9	13.3	11.8	14.3	28.3	31.6	34.6	31.5	45.2	47.7	46.8	46.7	1.38	1.59	1.89	1.62	7.2	5.8	4.9	5.9
8.	*Macroptilium atropurpureum*	14.2	11.5	10.5	12.1	27.5	30.1	33.1	30.2	49.1	50.0	47.3	48.9	1.18	1.37	1.67	1.41	8.0	6.9	7.4	7.4
	Mean	15.7	13.1	11.5	13.5	26.1	28.7	31.5	28.8	48.9	50.2	49.5	49.4	1.37	1.66	1.75	1.60	7.9	6.3	5.8	6.7
	Source			SEm ±	CD 5%			SEm ±	CD 5%			SEm ±	CD 5%			SEm ±	CD 5%			SEm ±	CD 5%
	Genotype (G)			0.04	0.12			0.04	0.11			0.01	0.03			0.01	0.05			0.01	0.02
	Stage (S)			0.02	0.07			0.02	0.06			0.01	0.02			0.01	0.03			0.01	0.01
	G x S			0.07	0.21			0.06	0.19			0.02	0.05			0.03	0.09			0.01	0.48
	Grasses Vs Legumes			0.16	0.47			0.16	0.47			0.16	0.46			0.12	0.46			0.16	0.46

I: Post flowering stage, II: 50% flowering stage, III: Pre-flowering stage.

mean total minerals content of 7.4 % within legumes fodder crops. The total minerals in Pawana, Marvel, Dongari grass and *Stylosanthes hamata* were 11.55, 8.67, 8.17and 10.47 per cent, respectively (Kauthale *et al*., 2017). Ahmed and Ahmed (2015) found 11.30 % total minerals in Ran mung.

Dry matter, cell wall constituents and *in vitro* dry mater digestibility

The dry matter content, cell wall constituents i.e. ADF, NDF, lignin and *in vitro* dry mater digestibility of forage grasses and legumes at different growth stages depicted in Table 2.

Dry matter

The grasses were higher in dry matter (DM) content than legumes fodder crops studied. The per cent mean dry matter content in grasses (42.57%) was higher than legume fodder crops (37.51%). Among the grasses and legumes, a grass, Marvel (*Dichanthium annulatum*) recorded the highest mean per cent dry matter (44.25%) and among the legumes, *Stylosanthes seabrana* recorded the highest mean per cent dry matter (40.25%) at all growth stages. The per cent DM was increased with the advancement of growth stages in both grasses and legumes. Among the fodder crops studied, Marvel (*Dichanthium annulatum*) recorded the highest dry matter content (56.0%) at post flowering stage.

Khan *et al.* (2017) reported 15.6, 20.8 and 21.1 per cent dry matter at early, medium and late growth stages, respectively in Madras anjan, and concluded that it was progressively increased with maturity of grasses. Similar results reported by Sultan *et al*. (2007). Jayprakash *et al*. (2016) reported dry matter content in Hedge lucerne and *Stylosanthes hamata* were 29.14 and 34.12 per cent, respectively.

ADF and NDF

Among the grasses and legumes fodder crops studied, *Stylosanthes seabrana* recorded the lowest mean per cent ADF of 35.63 and NDF of 46.93 per cent. Within the grasses, Marvel recorded significantly lowest mean per cent NDF and ADF of 63.77 and 40.30 per cent, respectively. Among the grasses and legumes fodder crops, a grass Marvel recorded the lowest per cent lignin of 4.90, whereas within the legumes, *Stylosanthes seabrana* recorded the lowest mean percent lignin of 8.76 %. As regards to cell wall constituents, it was observed that, ADF, NDF and lignin content were lower in legumes than grass fodder crops. These constituents were increased with the advancement of growth stages. The lowest cell wall contents were recorded at pre flowering stage, while highest at post flowering stage. Among all fodder crops studied, Marvel recorded lowest lignin per cent (3.79 %) at pre flowering stage.

Sultan *et al*. (2007) reported increase in ADF as well as NDF content from early bloom to maturity stage in Madras anjan from 31 to 33 % and 64 to 69 %, respectively. Musco *et al*. (2016) reported ADF of 42.13% and NDF of 49.91% in *Stylosanthes hamata*. Edgar *et al.* (2017) reported 16.92 % ADF and 34.82 % NDF in Dashrath grass. The NDF in Hedge lucerne was 49.7 per cent reported by Das *et al*. (2015).

Lignin

The legumes fodder were higher in lignin content than grasses studied. The per cent mean lignin content in grasses (5.02%) was lower than legume fodder crops (9.19%). Among the grasses and legumes, a grass, Marvel recorded the lowest mean per cent lignin (4.90%) and among the legumes, *Stylosanthes seabrana* recorded the lowest mean per cent lignin (8.76%) at all growth stages. The per cent lignin was increased with the advancement of growth stages in both grasses and legumes. Among the fodder crops studied, Marvel recorded the lowest lignin content (3.79%) at pre flowering stage.

Musco *et al*. (2016) reported 11.74% lignin. Ratnawaty *et al.* (2013) reported 11.32 % lignin in *Stylosanthes seabrana* harvested on 120 days after planting. Das *et al*. (2015) reported 10.2% lignin content in Hedge lucerne. The lignin content was increased with advancement of maturity, from 6.9 to 7.0 % in Siratro at pre-flowering and flowering stage, respectively, (Tokita *et al*., 2006).

***In vitro* dry matter digestibility**

Among the different growth stages studied, per cent IVDMD was decreased with the advancement of growth stages in both grasses and legumes. It was observed that mean per cent IVDMD was higher in legumes (59.13%) than grasses (54.87%). Among the grasses, *Dichanthium annulatum* recorded the highest mean per cent IVDMD (57.06%) and among the legumes, *Stylosanthes seabrana* recorded the

Table 2. Fodder quality of grasses and legumes at different growth stages

S. No.	Name of crop	Dry matter (%)				ADF (%)				NDF (%)				Lignin (%)				IVDMD (%)			
		I	II	III	Mean	I	II	III	Mean	I	II	III	Mean	I	II	III	Mean	I	II	III	Mean
	Grasses																				
1.	*Dichanthium annulatum*	36.0	40.6	56.0	44.25	36.2	39.9	44.8	40.30	61.9	63.5	65.9	63.77	3.79	5.16	5.74	4.90	60.3	57.3	53.5	57.06
2.	*Crysopogan fulvus*	34.5	36.7	53.1	41.5	43.1	47.3	49.2	46.54	62.0	71.4	73.6	69.00	3.93	5.14	5.97	5.01	54.8	51.5	50.0	52.14
3.	*Cenchrus ciliaris*	38.9	41.9	50.0	43.66	37.5	42.8	46.8	42.37	55.3	68.1	70.2	64.53	4.00	5.60	5.90	5.17	59.2	55.0	51.9	55.43
4.	*Sehima nervosum*	35.6	40.4	46.5	40.87	37.1	44.1	48.1	43.11	64.0	69.5	72.1	68.54	3.83	5.40	5.76	5.00	59.5	54.0	50.9	54.85
	Mean	36.3	39.9	51.4	42.57	38.4	43.5	47.2	43.08	60.8	68.1	70.4	66.45	3.88	5.32	5.84	5.02	58.5	54.5	51.5	54.87
	Legumes																				
5.	*Stylosanthes seabrana*	37.2	37.9	45.5	40.25	31.2	35.3	40.4	35.63	40.2	48.7	51.9	46.93	7.14	8.39	10.73	8.76	64.2	61.0	56.9	60.75
6.	*Stylosanthes hamata*	30.2	36.6	37.7	34.88	30.4	38.8	40.6	36.60	42.8	48.9	52.8	48.17	7.30	8.56	10.93	8.93	64.8	58.2	56.8	59.99
7.	*Deshmanthus virgatus*	37.5	36.0	45.6	39.75	32.4	40.7	45.3	39.50	51.2	51.4	55.5	52.70	8.56	8.60	11.23	9.46	63.3	56.7	53.0	57.69
8.	*Macroptilium atropurpureum*	30.4	35.3	39.6	35.17	36.3	38.5	42.2	39.00	50.2	54.8	52.8	52.60	9.10	8.98	10.74	9.61	60.2	58.4	55.5	58.09
	Mean	33.8	36.5	42.1	37.51	32.5	38.3	42.1	37.68	46.1	50.9	53.2	50.10	8.02	8.63	10.90	9.19	63.1	58.6	55.6	59.13
	Source			SEm ±	CD 5%			SEm ±	CD 5%			SEm ±	CD 5%			SEm ±	CD 5%			SEm ±	CD 5%
	Genotype (G)			0.18	0.52			0.06	0.18			0.01	0.04			0.09	0.25			0.04	0.130
	Stage (S)			0.11	0.32			0.04	0.11			0.00	0.02			0.05	0.15			0.02	0.079
	G x S			0.32	0.90			0.11	0.31			0.02	0.06			0.15	0.44			0.08	0.224
	Grasses Vs Legumes			0.19	0.53			0.17	0.47			0.16	0.46			0.17	0.48			0.16	0.473

I: Post flowering stage, II: 50% flowering stage, III: Pre-flowering stage.

Table 3. Calcium, magnesium and zinc content in grasses and legumes at different growth stages

S No.	Name of crop	Calcium				Magnesium				Zinc			
		I	II	III	Mean	I	II	III	Mean	I	II	III	Mean
	Grasses												
1.	*Dichanthium annulatum*	0.23	0.19	0.15	0.19	0.36	0.34	0.27	0.33	8.31	7.24	5.31	6.95
2.	*Crysopogan fulvus*	0.14	0.17	0.10	0.14	0.23	0.20	0.16	0.20	8.63	6.77	4.90	6.76
3.	*Cenchrus ciliaris*	0.19	0.16	0.13	0.16	0.23	0.25	0.19	0.22	7.92	6.57	5.29	6.59
4.	*Sehima nervosum*	0.21	0.17	0.10	0.16	0.27	0.21	0.17	0.22	8.40	5.61	4.34	6.11
	Mean	0.20	0.16	0.12	0.16	0.26	0.25	0.19	0.24	8.29	6.54	4.96	6.60
	Legumes												
5.	*Stylosanthes seabrana*	2.16	2.11	2.03	2.10	0.32	0.29	0.26	0.29	12.23	11.19	9.81	11.07
6.	*Stylosanthes hamata*	2.09	2.13	1.97	2.06	0.31	0.27	0.24	0.28	11.42	9.87	8.03	9.77
7.	*Deshmanthus virgatus*	2.08	2.0	1.93	2.00	0.29	0.24	0.18	0.23	10.14	8.88	7.89	8.97
8.	*Macroptilium atropurpureum*	1.10	1.03	0.98	1.04	0.22	0.27	0.14	0.21	10.02	9.10	7.92	9.01
	Mean	1.85	1.81	1.72	1.79	0.28	0.26	0.20	0.25	10.95	9.76	8.41	9.71
	Source			SEm ±	CD 5%			SEm ±	CD 5%			SEm ±	CD 5%
	Genotype (G)			0.018	0.049			0.006	0.017			0.065	0.184
	Stage (S)			0.011	0.030			0.004	0.010			0.040	0.112
	G x S			0.030	NS			0.011	0.030			0.113	318
	Grasses Vs Legumes			0.167	0.469			0.167	0.468			0.170	0.477

I: Post flowering stage, II: 50% flowering stage, III: Pre-flowering stage.

highest mean per cent IVDMD (60.75%) of all growth stages. Among the fodder crops evaluated, *Stylosanthes hamata* recorded the highest IVDMD (64.8%) at pre flowering stage.

Sultan *et al*. (2007) reported decline in *in vitro* dry matter digestibility with advancement of maturity Madras anjan (*Cenchrus ciliaris* L.). The lowest IVDMD in Madras anjan at early bloom stage was 58.6 per cent and it was declined to 36.6 per cent at maturity stage. *In vitro* dry matter digestibility in Marvel at early bloom stage was 51.4 % whereas, at maturity stage decreased up to 39.5% (Sultan *et al*., 2008).

Calcium, Magnesium and Zinc

Calcium, magnesium and zinc content in forage grasses and legumes at different growth stages depicted in Table 3. The legumes were higher in calcium content than grasses. Calcium content was higher at pre flowering stage and declined towards the maturity of crop. Among the all fodder crops studied, *Stylosanthes seabrana* recorded the highest mean per cent Ca of 2.10 %, while, among grasses, Marvel recorded the highest mean Ca of 0.19 % of all growth stages.

Differences in Mg content among the grasses and legumes were not wide. However, Marvel recorded the highest mean Mg content (0.33%) among the grasses, while among the legumes, *Stylosanthes seabrana* recorded the highest mean Mg of 0.29% of all growth stage.

All fodder legumes were higher in zinc content than grasses. Zinc content was higher at pre flowering stage and declined towards maturity of crop. Among the all fodder crops studied, *Stylosanthes seabrana* recorded the highest mean zinc content of 11.07 ppm, while among the grasses, Marvel recorded the highest mean zinc content of 6.95 ppm of all growth stage.

Jayprakash *et al*. (2016) reported Ca content in Hedge lucerne and *Stylosanthes hamata* were 2.15 and 2.11%, respectively. Kumar *et al.* (2016) reported that Ca content in Madras anjan, Marvel and Stylo were 0.17, 0.14 and 0.73%, respectively. Sultan *et al.* (2008) reported Mg content in Marvel at early bloom stage (0.032%) was declined at maturity stage (0.030 %). Melesse *et al*. (2017) reported 1.86% zinc in Madras anjan at pre-flowering stage.

CONCLUSION

The biochemical evaluation of four grasses and four legumes at different growth stages for nutritional parameters revealed that, per cent dry matter, CF, EE, ADF, NDF and lignin, in grasses as well as legumes were increased with advancement of growth stages. While per cent CP, total minerals, Ca, Mg, Zn and IVDMD were decreased with advancement of growth stages. Among the four grasses evaluated,

Marvel recorded the highest mean dry matter, EE, NFE, IVDMD, total minerals, Ca, Mg and Zn as well as lowest CF, NDF, ADF and lignin. Among the four legumes evaluated *Stylosanthes seabrana* recorded the highest dry matter, CP, EE, NFE, IVDMD, Ca, Mg and Zn as well as lowest CF, NDF, ADF and lignin. While, Ran mung recorded the highest total mineral content than other legumes. Marvel within grasses and *Stylosanthes seabrana* within legumes were found better for most of the fodder quality parameters. Among the growth stages, quality of forage at pre flowering was better than other cutting stages, however cutting of forage crops at 50% flowering stage is always preferred because of higher yield with better forage quality.

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