Research Article

Nutritional Evaluation of Three Panicum Forage Species at Different Growth Stages

Ashar Farooq[1]*, Mohammad Salim[2], Zahid Rauf[1], Muhammad Tahir Khan[3] and Asad Abbas Khan[4]

[1]Pakistan Forest Institute, Peshawar, Khyber Pakhtunkhwa, Pakistan; [2]Department of Forestry and Wildlife Management, University of Haripur, Khyber Pakhtunkhwa, Pakistan; [3]Department of Animal Nutrition, The University of Agriculture, Peshawar,Khyber Pakhtunkhwa, Pakistan; [4]Barani Livestock Production Research Institute, Kerimurat, Attock, Punjab, Pakistan.

Abstract | Forages play a crucial role in livestock feed, significantly influencing overall livestock production. Understanding nutritional value of forages is essential for making informed decisions in sustainable livestock production systems. This study was focused to evaluate the nutritive value of three Panicum grasses at different growth phases. RCBD with factorial arrangement was employed, consisting of four replications. The treatments included three Panicum species: *P. antido tale, P. coloratum* and *P .maximum*, each assessed at different growth phases i.e., pre-boot, full-flowering and seed-ripe. Fresh grass samples were collected and analyzed for several quality parameters. The samples were oven-dried in order to determine dry matter (DM) yield and subsequent analysis for Crude Protein (CP), Ash Content, Ether Extract (EE), Crude Fiber (CF), Acid Detergent Fiber (ADF) and Neutral Detergent Fiber (NDF). ANOVA test was applied on the data to determine the considerable differences of means which were further separated through Tukey's range test. Results revealed that DM, CF, Ash, ADF and NDF were increased considerably when the grasses progressed from the pre-boot to the seed-ripe stage. In contrast, CP and EE significantly declined when the Panicum species reached towards maturity. These results suggest that the optimal harvesting time for maximizing nutritive value occurs between the pre-boot and full-flowering stages. Based on higher nutritive values (higher CP and EE and lower CF, NDF and ADF), *P. coloratum* and *P. maximum* are identified as the promising forage species for meeting nutritional requirements of livestock. It is recommended for the farmers to grow these perennial forage species for better livestock production.

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***Correspondence** | Ashar Farooq, Pakistan Forest Institute, Peshawar, Khyber Pakhtunkhwa, Pakistan; Email: asharfarooq1973@gmail.com
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Introduction

Panicum antidotale, *Panicum coloratum* and *Panicum maximum* are considered as the most popular and frequently utilized grasses for forage among the genus Panicum throughout the world (Aliscioni *et al*., 2003). The production of livestock, a significant part of the agricultural production system, is closely linked to the production of fodder. In both developed and developing nations, this sector accounts for

about 40% and 20% of total agricultural production, respectively. Additionally, it sustains the lives of billions people globally (FAO, 2018). Livestock sector has significantly contributed to foreign exchange in Pakistan during the last few years. Its contribution to foreign exchange earnings is approximately 3.1% during the financial year 2019-2020, that is 11.70% of the gross domestic product (Anonymous, 2020). It is significant to comprehend the forage quality of different species and how they impact animal husbandry. High-quality feed and sustainable pasture management significantly improve animal health and performance, increasing growth rates, milk output, resistance to disease and reproductive success. Because of their great nutritional content and high yield, forage grasses are crucial for providing animals with the nutrition they need. These perennial forages are useful in livestock feeding programs. Forage grasses are used to make silage and hay during the cold weather when there is a shortage of forage. Demand of the situation is introducing the fodder species having high nutritive value, high forage production and widely adaptable which could help mitigate the deficit of livestock feed and overall production of livestock (Jamil *et al*., 2018).

Comparative study of the nutritional value of different *Panicum* species at various clipping stages has not been conducted in Pakistan. In this context, this study was carried out and focused on evaluating the comparative nutritional value and cell wall content of *P. antidotale*; *P. coloratum* and *P. maximum* species at three growth phases.

Materials and Methods

The experimental site is located in the range research area of Pakistan Forest Institute, Peshawar. Figure 1 demonstrates the study area. Randomized Complete Block Design (RCBD) was employed with four replications and a factorial arrangement. Treatments included three grass species and three cutting stages i.e., Pre-boot, full-flowering and seed-ripe. The trial was conducted during March-November, 2020. Sample plot (quadrat) of 1m x 1m size was used to collect forage samples for calculating fresh weight.

Nutritive value analysis

Proximate analysis: Nutritional value of the forage was assessed by analyzing grass samples in the Animal Nutrition Department's Forage Nutrition Laboratory at the University of Agriculture, Peshawar. Chemical analysis, sometimes referred to as proximate analysis, was used to ascertain ash content, dry matter (DM), crude fiber (CF), ether extract (EE) and crude protein (CP). The AOAC (2007) procedure was used to assess these parameters. Acid detergent fiber (ADF) and neutral detergent fiber (NDF) were measured using an ANKOM fiber analyzer (Ammar *et al*., 1999) and the catalysts described by Van Soest *et al*. (1991).

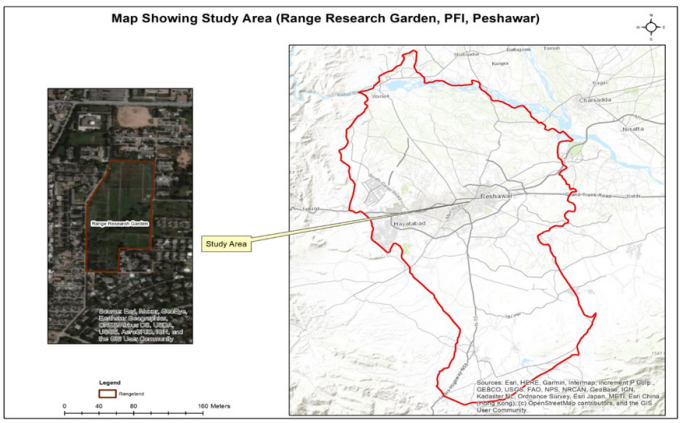

Figure 1: *Showing map of study area.*

Detergent fiber system

A more precise method for determining the amount of carbohydrates in forages is the detergent fiber technique. Structural carbohydrates are separated into fractions of ADF and NDF. In this process, the fractions were identified using two detergents.

Data processing

SPSS statistics software was used to analyze the data. The means of the measured and analyzed parameters for each treatment were examined using analysis of variance (ANOVA). Further, Tukey's range test was applied to substantially different means.

Results and Discussion

Results of the data analysis are presented in Table 1 and Table 2. The nutritive value parameters studied are described as follows:

Dry matter (%)

The dry matter (DM) content of all three species at three different cutting stages illustrated in Figure 2 reveals that it is increased from the pre-boot stage to the seed-ripe stage. *P. antidotale* contained the highest DM (%) following *P. maximum* and *P. coloratum*. The analysis revealed a significant difference between the three species, with *P. antidotale* exhibiting a

Table 1: *Showing statistical analysis of comparison between grass species regarding nutritive value.*

Nutritive value parameter	(I) species	(J) species	Mean difference (I-J)
DM	*P. antidotale*	*P. coloratum*	2.7511*
		P. maximum	1.4833*
	P. coloratum	*P. antidotale*	-2.7511*
		P. maximum	-1.2678*
	P. maximum	*P. antidotale*	-1.4833*
		P. coloratum	1.2678*
CP	*P. antidotale*	*P. coloratum*	-4.9889*
		P. maximum	-6.9222*
	P. coloratum	*P. antidotale*	4.9889*
		P. maximum	-1.9333*
	P. maximum	*P. antidotale*	6.9222*
		P. coloratum	1.9333*
Ash	*P. antidotale*	*P. coloratum*	-1.9511*
		P. maximum	-4.7311*
	P. coloratum	*P. antidotale*	1.9511*
		P. maximum	-2.7800*
	P. maximum	*P. antidotale*	4.7311*
		P. coloratum	2.7800*
EE	*P. antidotale*	*P. coloratum*	-0.4533*
		P. maximum	-0.4844*
	P. coloratum	*P. antidotale*	0.4533*
		P. maximum	-0.0311
	P. maximum	*P. antidotale*	0.4844*
		P. coloratum	0.0311
CF	*P. antidotale*	*P. coloratum*	-0.5478*
		P. maximum	-2.4067*
	P. coloratum	*P. antidotale*	0.5478*
		P. maximum	-1.8589*
	P. maximum	*P. antidotale*	2.4067*
		P. coloratum	1.8589*
NDF	*P. antidotale*	*P. coloratum*	-5.3778*
		P. maximum	-1.7811*
	P. coloratum	*P. antidotale*	5.3778*
		P. maximum	3.5967*
	P. maximum	*P. antidotale*	1.7811*
		P. coloratum	-3.5967*
ADF	*P. antidotale*	*P. coloratum*	-8.1389*
		P. maximum	-4.7733*
	P. coloratum	*P. antidotale*	8.1389*
		P. maximum	3.3656*
	P. maximum	*P. antidotale*	4.7733*
		P. coloratum	-3.3656*

** The mean difference is significant at the 0.05 level.*

Table 2: *Statistical analysis of comparison between growth stages regarding nutritive value.*

Nutritive value parameter	(I) Stage	(J) Stage	Mean difference (I-J)
DM	Pre-boot	Full flowering	-2.7389*
		Seed ripe	-2.5400*
	Full flowering	Pre-boot	2.7389*
		Seed ripe	.1989
	Seed ripe	Pre-boot	2.5400*
		Full flowering	-.1989
CP	Pre-boot	Full flowering	4.5222*
		Seed ripe	8.5333*
	Full flowering	Pre-boot	-4.5222*
		Seed ripe	4.0111*
	Seed ripe	Pre-boot	-8.5333*
		Full flowering	-4.0111*
Ash	Pre-boot	Full flowering	-3.4911*
		Seed ripe	-5.6844*
	Full flowering	Pre-boot	3.4911*
		Seed ripe	-2.1933*
	Seed ripe	Pre-boot	5.6844*
		Full flowering	2.1933*
EE	Pre-boot	Full flowering	.4178*
		Seed ripe	.2544*
	Full flowering	Pre-boot	-.4178*
		Seed ripe	-.1633
	Seed ripe	Pre-boot	-.2544*
		Full flowering	.1633
CF	Pre-boot	Full flowering	-4.2689*
		Seed ripe	-8.6556*
	Full flowering	Pre-boot	4.2689*
		Seed ripe	-4.3867*
	Seed ripe	Pre-boot	8.6556*
		Full flowering	4.3867*
NDF	Pre-boot	Full flowering	-4.7944*
		Seed ripe	-8.5878*
	Full flowering	Pre-boot	4.7944*
		Seed ripe	-3.7933*
	Seed ripe	Pre-boot	8.5878*
		Full flowering	3.7933*
ADF	Pre-boot	Full flowering	-4.6122*
		Seed ripe	-5.1100*
	Full flowering	Pre-boot	4.6122*
		Seed ripe	-.4978
	Seed ripe	Pre-boot	5.1100*
		Full flowering	.4978

** The mean difference is significant at the 0.05 level.*

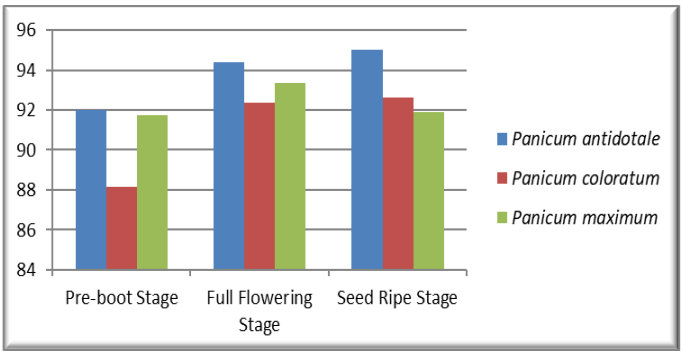

Figure 2: *Dry matter (%) of three Panicum species at three different growth stages.*

significantly higher DM percentage than the other two species, while *P. coloratum* had the lowest. The data indicate that DM percentage increases when forages mature from the pre-boot stage to the full flowering stage, supporting findings by Mushtaque *et al.* (2010), Ahmad *et al.* (2012), Lounglawan *et al.* (2014) and Chiphwanya *et al.* (2017). Increase in DM is attributed to rising fiber content (cell wall contents) as grasses approach maturity. Arshadullah *et al.* (2006) reported that *P. maximum* produced 9.32 t/ha of dry biomass, while *P. antidotale* yielded 6.78 t/ha. Conversely, Arshadullah *et al.* (2009) found that the DM yield of *P. antidotale* (Blue panic) was superior to that of *P. maximum* (Guinea grass).

Crude protein (%)

The crude protein (CP) content of the three Panicum grasses is illustrated in Figure 3. It shows that CP levels decrease from the pre-boot stage to the seed-ripe stage. *P. maximum* showed the highest CP percentage, following *P. coloratum*. CP content was highest at the pre-boot stage, decreased during the full-flowering stage and was the lowest at the seed-ripe stage.

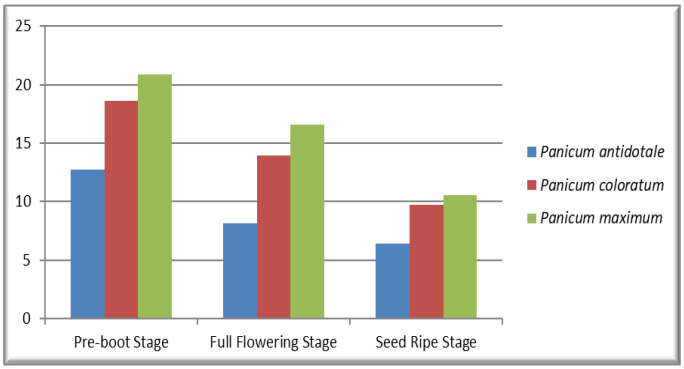

Figure 3: *Crude protein (%) of three Panicum species at three different growth stages.*

The results are matching with the conclusions of Agza *et al.* (2013), Katoch *et al.* (2013), Ismail *et al.* (2015) and Chiphwanya *et al.* (2017) who reported similar results of decline in CP contents with time. Microbial activity in animal feed can be decreased with CP less than 6-7% due to un-availability of nitrogen in the rumen. *P. maximum* had the highest CP (%) following *P. coloratum* and *P. antidotale*. The decline in CP is due to the fact that with maturity, stem-ratio and cell-wall contents increase which ultimately reduces leaf ratio.

Ether extract (%)

Figure 4 illustrates the ether extract (EE) content of the Panicum grasses. It is evident that the EE (%) of the grass species declines from the pre-boot stage to the seed-ripe stage. The analysis indicated that EE levels reduced as the grasses matured, with the highest EE recorded at the pre-boot stage, following full-flowering and seed-ripe stage. Katoch *et al.* (2013) and Chiphwanya *et al.* (2017) also reported a decline in EE content with maturity. Among the species, *P. maximum* had the highest EE percentage following *P. coloratum* and *P. antidotale*.

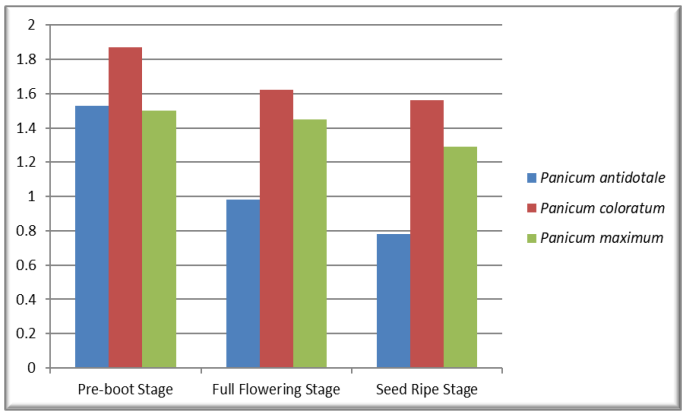

Figure 4: *Ether extract (%) of three Panicum species at three different growth stages.*

Ash (%)

The ash content of the Panicum grasses is illustrated in Figure 5. The data shows that ash content increased from pre-boot stage to seed-ripe stage. Ash content represents total minerals in the forage, including phosphorus, potassium, calcium and magnesium. As the grasses mature, ash content rises, with the highest levels observed at the seed-ripe stage following full-flowering and pre-boot stage. Again, *P. maximum* exhibited the highest ash percentage following *P. coloratum* and *P. antidotale*. The rise in ash content with the maturity is attributed to the increase in fiber contents as the forages grow (Chiphwanya *et al.*, 2017).

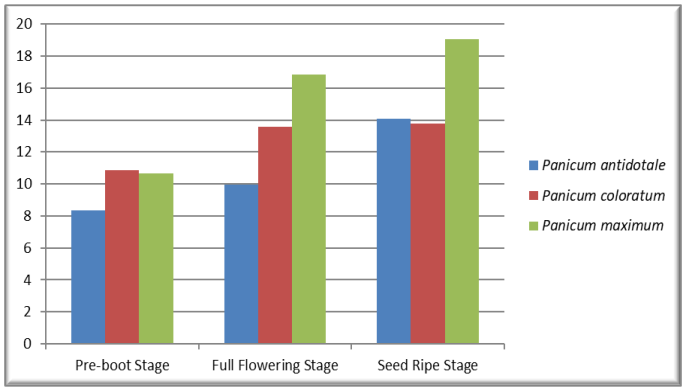

Figure 5: *Ash (%) of three Panicum species at three different growth stages.*

Crude fiber (%)

The crude fiber (CF) content of the Panicum species is shown in Figure 6. *P. antidotale* had the maximum CF percentage following *P. coloratum* and *P. maximum*. CF content increases as the grasses mature corresponding to greater cell wall thickness. The highest CF levels were recorded at the seed-ripe stage following full-flowering, with the lowest at the pre-boot phase. The results are in line with the findings of an increase in CF content over time by Distel *et al.* (2005) and Chiphwanya *et al.* (2017).

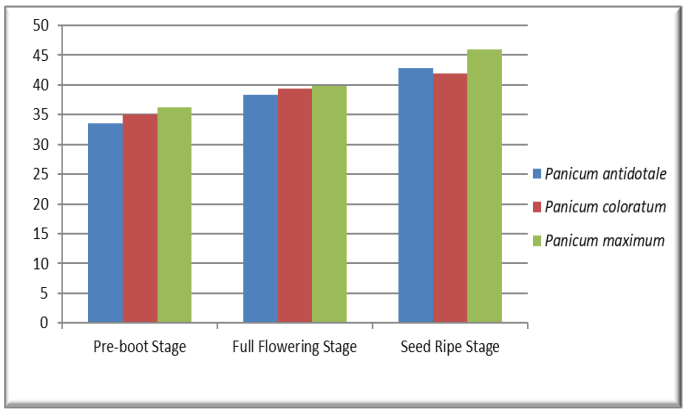

Figure 6: *Crude fiber (%) of three Panicum species at three different growth stages.*

Neutral detergent fiber (%)

Figure 7 shows the NDF (%) of the Panicum grasses. The slow-digestible and indigestible components of animal feed are represented by the fibrous carbohydrates cellulose, hemi-cellulose and lignin that constitute NDF. Species with the greatest percentage was *P. coloratum*, which was followed by *P. maximum* and *P. antidotale*. The pre-boot stage had the lowest NDF level, following the full-flowering stage and seed-mature stage. The rise in fiber content as the grasses grow is thought to be the cause of the increase in NDF content with phenological development. The results are in line with the findings of an increase in NDF content over time by Chiphwanya *et al.* (2017) and Jagadeesh *et al.* (2017).

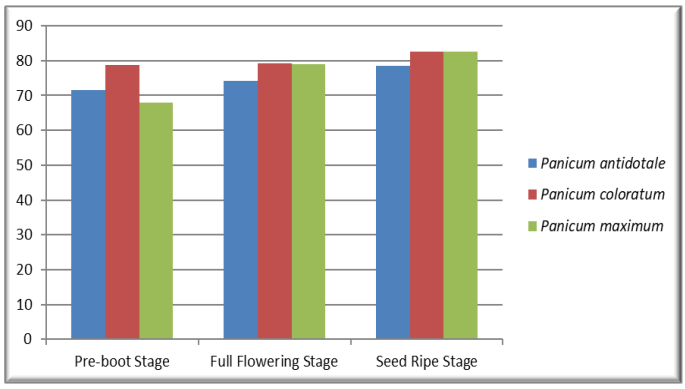

Figure 7: *Neutral detergent fiber content of three Panicum species at three different growth stages.*

Acid detergent fiber (%)

Figure 8 shows the ADF (%) the three Panicum grasses. ADF, which includes cellulose and lignin but not hemicellulose, is the part of forages that is least digested. It's frequently called fibrous carbs. The species with the highest ADF % was *P. coloratum*, which was followed by *P. maximum* and *P. antidotale*. The pre-boot stage had the lowest ADF content, following the full flowering and seed mature stage. The rise in cell wall components as the grasses mature is thought to be the cause of the increase in ADF content with phenological development. The outcomes are consistent with research by Tessema *et al.* (2010), Reddy and Seshi (2012), Agza *et al.* (2013), Chiphwanya *et al.* (2017) and Jagadeesh *et al.* (2017).

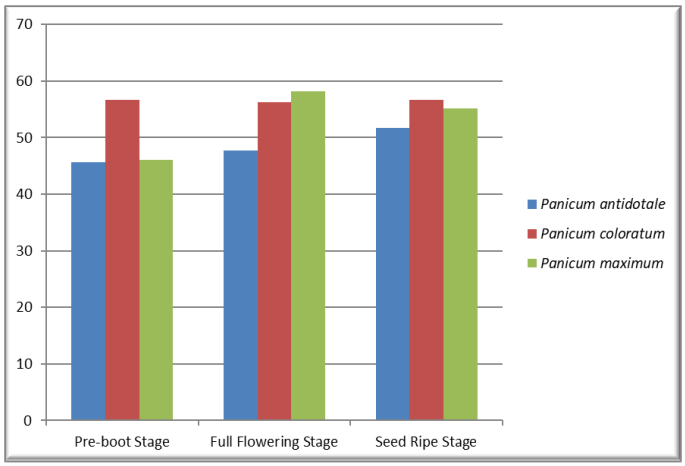

Figure 8: *Acid detergent fiber content of three Panicum species at three different growth stages.*

Conclusions and Recommendations

It is concluded that *P. maximum* has significantly

higher nutritive value than that of *P. coloratum* and *P. antidotale*. Compared to pre-boot and seed mature stages, crude protein is higher during the full flowering stage. The ideal time to pick these grasses is when they are fully blooming. Early in their growth, CP and EE exhibited a stronger tendency and as they matured, they showed a decline. As the grasses progressed toward maturity, their soluble percentage dropped but their cell wall content (cellulose, hemicellulose and lignin) increased.

P. coloratum and *P. maximum* are recommended as cultivated fodder crops for sustainable livestock feeding. Furthermore, farmers can utilize the air dried and processed stuff of these grasses during cold weather.

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Novelty Statement

Nutritive value of forages plays a vital role in maximizing animal production of meat and milk. This study has focused on the identification of Panicum species having more nutritive value which will greatly help the livestock rearing farmers for the best choice of forages.

Author's Contribution

Ashar Farooq: Concept, design and writing the manuscript.
Mohammad Salim: Critical thinking and proof reading.
Zahid Rauf: Statistical analysis of data.
Muhammad Tahir Khan: Laboratory analysis of forage samples.
Asad Abbas Khan: Laboratory analysis of forage samples.

Conflict of interest
The authors have declared no conflict of interest.

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