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Fiber content analysis of sorghum [*Sorghum bicolor* (L.) Moench] germplasm lines

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Abstract
This study was performed at Instructional dairy farm, Govind Ballabh Pant University of agriculture and technology during *Kharif* season, 2017 to evaluate and characterize 96 sorghum accessions for various morphological and fodder yield parameters. Nutritional characters of 25 selected lines with high protein and low HCN are evaluated. Nutritional characters like cellulose, hemicelluloses, ADF, NDF, silica and lignin were studied. Lowest content of NDF, ADF, cellulose, lignin and silica were reported in IS31861 (51.3%), IS-4925 (29.7%), IS-3865 (25%), IS-20399 (3.35%) and IS-4925 (0.85%) respectively. These accessions can be used as donor parents for the nutritional characters in the breeding programme.

Keywords: Accessions, evaluation, fodder yield, morphological traits, selection, ADF, NDF

Introduction
Sorghum is a staple crop cultivated in the semi-arid and sub-tropical regions of African and Asian countries. There are five cultivated races in sorghum and these are bicolor, kafir, durra, caudatum and guinea. Sorghum [*Sorghum bicolor* (L.) Moench] has originated in Northeastern Africa about 5000 – 8000 years ago (De Candolle 1884) [2]. Its domestication is most likely in the Ethiopian-Sudan border (Doggett 1988) [3]. It is one of the most drought-tolerant cereal crops, which can be cultivated in diverse climates and environmental conditions for food, feed, fiber, and fuel. It is planted in those areas which are considered to be hot and dry for other cereal crops because of its tolerance to heat and drought stress (Poehlman, 1987) [7]. It is a short duration crop and well adaptive to arid regions and considered as promising crop to overcome the fodder shortages in uncertain areas. It is a palatable and very nutritious fodder crop for animals. There is enormous demand for green and dry fodder particularly during lean winter and summer season in the arid and semi-arid region. During the last 30 years the role of sorghum as a major source of fodder has not diminished while its importance as a forage crop has increased (Tonapi *et al.*, 2011) [10]. For increasing livestock productivity in India there is a need of good quality fodder and low fodder production and lesser-feed availability is the major limiting factor. To meet the demand there is need of increase in the production and it should come from it or even less area in the present situation of shrinking agricultural land (Prakash *et al*., 2010) [8]. Improvement in livestock production depends on the proper quality and quantity of feed and fodder. 60-70 per cent of total cost in livestock production is due to feed and fodder and in India very less area of the total cropped area is utilized to grow fodder. India is deficit in dry fodder, green fodder and concentrates feed. Low availability of fodder leads to poor feeding of the animal which results in low milk and meat yields. Due to expanding human population and improvement in life style of citizens demand for animal products for human consumption is increasing day by day. Therefore, comprehensive knowledge of germplasm diversity and genetic relationships among sorghum accessions will remain an important aid in the crop improvement strategies for breeding programs (Mohammadi and Prasanna, 2003) [5]. Progress in developing high fodder yield sorghum varieties or hybrids by using different plant breeding techniques depends on the extent of genetic variability present in a population. Therefore, the first step in any plant breeding program is to assess the magnitude of genetic variability present in the population. Many studies are done to assess patterns of genetic variation based on morphology or pedigree (Agrama and Tuinstra, 2003) [1]. The maximum genetic variability is present in the germplasm, screening and evaluation of the germplasm for different fodder quality characters becomes really important for fulfilling the good quality fodder demand.

Material and method
The present study was conducted at the Instructional Dairy Farm of the Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India during *Kharif* 2017.

96 germplasm accessions were used for the study and planted in an Augmented Block Design. Each genotype were sown in two rows of 3 metre length with a row spacing of 45cm. Recommended package of practices were followed to grow the normal healthy crop. An average rainfall of 948.6mm is experienced annually. Data was recorded of 25 selected germplasm lines with high protein content and low HCN on ADF, NDF, cellulose, hemicelluloses, silica and lignin.

Neutral detergent fiber (NDF) is a common measure of fiber used for animal feed analysis, it measures the structural components of plant cells (i.e. lignin, cellulose and hemicellulose), but not pectin. The proximate procedures using detergents have been proposed by Van Soest (1991) [11]. It is a rapid method for analyzing the total fiber.

$$\text{Cell wall constituents in \% (NDF)} = \frac{(\text{Weight of crucible+cell wall constituent}) - \text{Weight of crucible}}{\text{Weight of dry sample}} \times 100$$

Acid detergent fiber (ADF) represents the least digestible fiber portion of forage. This is the highly indigestible part of forage and includes lignin, cellulose, silica and insoluble forms of nitrogen but not hemicellulose. The difference between the cell walls and ADF is an estimate of hemicellulose. The ADF is used as a preparatory method for lignin determination.

$$\text{Acid detergent fiber percent on dry matter basis} = \frac{\text{Weight of crucible+ash} - \text{Weight of crucible}}{\text{Weight of dry sample}} \times 100$$

Hemicellulose % = Neutral detergent fiber %-Acid detergent fiber%

From Acid detergent fiber lignin, cellulose and silica are separated and their amount is determined.

$$\text{Lignin content \%} = \frac{\text{Weight of acid detergent fiber} - \text{weight of permanganate acid residue}}{\text{Weight of sample taken for acid detergent fiber determination}} \times 100$$

$$\text{Cellulose content \%} = \frac{\text{Weight of crucible and permanganate fiber residue} - \text{Weight of crucible and ash}}{\text{Weight of sample taken for determination of acid detergent fiber}} \times 100$$

$$\text{Silica content \%} = \frac{\text{Weight of ash after hydrogen bromide washing}}{\text{Weight of sample taken for acid detergent fiber determination}} \times 100$$

Result and discussion

An experiment was conducted to test the cell wall components like cellulose, hemicelluloses, ADF, NDF, silica, lignin of some selected genotypes with high protein content and low HCN. These components are difficult to digest so a lowest amount of these components is required for good digestibility of the fodder. The observations are presented in the Table 1.

From this study it was recorded that the lowest content of NDF (%) is present in IS31861 (51.3) followed by IS-1478 (51.75), lowest ADF (%) was reported in IS-4925 (29.7), IS-3865 (30.4), Pant elite line 2040 (30.45) and Pant elite line 2038 (31) accessions while lowest cellulose content (%) was reported in IS-3865 (25), IS-4925 (25.2), lowest Lignin content (%) was reported in IS-20399 (3.35), Pant elite line 2025 (3.35), lowest Silica content (%) was reported in IS-4925 (0.85), IS-639 (0.95), and lowest Hemicellulose content (%) was reported in IS31861 (13.35), IS-21461 (14.9), IS-1478 (15) and IS-20740 (16.25). In this study some lines were identified that contained low content of two or more cell wall components and these were pant elite line 2040 found to contain lowest content of ADF, cellulose and silica content. IS-4925, IS-3865 and pant elite line 2038 observed to contain lowest ADF and cellulose content. These accessions can be used as donor for their respective nutritional characteristics in the breeding programme. Good quality fodder plays an important role in animal health. Chemical and nutrient composition of sorghum varieties should be considered when selecting for broiler chicken feeding. (Mabelebele *et al.*, 2015) [4]. Roy *et al.*, 2019 [9] stated that evaluation of various feeds ingredients is helpful in balanced ration formulation for field ruminants and under farm conditions for better utilization of these commonly available feed resources. Total tract neutral detergent fiber (NDF) digestibility was compared between the bmr-6, bmr-18 sorghum and corn silage (Oliver *et al.*, 2004) [6]. Greatest NDF digestability was found for the bmr-6 sorghum (54.4%) and corn silage (54.1%) diets and was lower for the conventional (40.8%) and bmr-18 sorghum (47.9%) diets.

Table 1: Mean values of nutritional quality characteristics of selected genotypes

Si. No.	Genotypes	NDF (%)	ADF (%)	Cellulose (%)	Lignin (%)	Silica (%)	Hemicellulose (%)
1	IS-313	52.1	35.1	26.55	5.35	3.2	17
2	IS-639	58.5	32.75	27.55	4.25	0.95	25.75
3	IS-1219	55	33.55	27.7	4.7	1.15	21.45
4	IS-1478	51.75	36.75	29.25	4.8	2.7	15
5	IS-3199	55.15	34.35	27.85	5.15	1.35	20.8
6	IS-3313	53.5	34.2	28.15	4.5	1.55	19.3
7	IS-3353	52.05	34.35	26.8	5.1	2.45	17.7
8	IS-3865	56.4	30.4	25	3.75	1.65	26
9	IS-4925	57.4	29.7	25.2	3.8	0.85	27.7
10	IS-5434	55.1	32.7	27	4.2	1.5	22.4
11	IS-6090	52.6	31.45	25.65	4.25	1.4	21.15

12	IS-6953	53.85	32.55	27.05	3.95	1.55	21.3
13	IS-9162	54.2	32.4	25.85	3.65	2.9	21.8
14	IS-20399	57.6	32.35	27.5	3.35	1.5	25.25
15	IS-20740	53.2	36.95	30.2	5.25	1.5	16.25
16	IS-21461	54.15	39.25	31.95	5.5	1.8	14.9
17	IS23948	54.55	34.5	29.45	3.55	1.5	20.05
18	IS23992	53.2	32.3	26.6	3.9	1.8	20.9
19	IS31861	51.3	37.95	28.55	7.25	2.15	13.35
20	Pant elite line 2008	52.6	32.35	27.7	3.55	1.1	20.25
21	Pant elite line 2014	54.45	32.95	27.1	4.35	1.6	21.5
22	Pant elite line 2038	52.2	31	25.25	3.85	1.9	21.2
23	Pant elite line 2019	56.15	35.95	30.05	3.45	2.45	20.2
24	Pant elite line 2025	56.4	35.45	29.9	3.35	2.2	20.95
25	Pant elite line 2040	54	30.45	25.4	4.05	1	23.55

Conflict of interest: The authors declare that they have no conflict of interest.

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