Genetic Variability in Sorghum Exotic Accessions for Nutritional Attributes and Methane Emission Potential

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Introduction

Sorghum an important fodder crop grown for multiple uses as fodder, food and fuel constitute major chunk of forage produced in India. Over the past years Indian farmer's preference to dual purpose sorghum has changed. Introduction of dual-purpose sorghum varieties to sustain rural development, enhance renewable energy production and improve food security has been stressed Genetic variability of sorghum may be exploited to bred dual purpose hybrids/varieties for higher fodder yield without compromising grain yield.Substantial variations in the fodder value of sorghum stovers have been reported that supports the concept of genetic enhancement to improve dual-purpose sorghum cultivars. Under the present study exotic accessions of sorghum were evaluated for their genetic variability in nutritive value and methane production potential.

Materials and Methods

Sorghum exotic accessions (21 numbers, EC512373 to EC512395) were grown at Crop Improvement division of IGFRI in Kharif 2010 following similar agronomic practices. Samples of these accessions collected at 50 % flowering were evaluated for proximate constituents as per method of AOAC, 2000. Neutral detergent fiber (NDF), acid detergent fiber (ADF), cellulose and lignin contents were estimated following method of Van Soest *et al.*, 1991. Soluble protein (SP) and NPN of stover samples were estimated as per the standard procedures. Carbohydrate and protein fractions were calculated as per Cornell Net Carbohydrate and Protein system (Sniffen *et al*., 1992). Net energy (NE) for different animal functions (lactation -NE_L, growth-NE_G and maintenance-NE_M) and in vitro methane production (g/kg DDM) were calculated using different equations.

Results and Discussion

Sorghum exotic accessions CP and EE contents ranged between 5.2-7.3 and 0.97-2.55 %, respectively. Mean contents of NDF, ADF, cellulose and lignin of accessions were 68.73, 39.00, 31.28 and 6.52 %, respectively. EC512381 had lowest contents of NDF (59.84), ADF (35.30) and cellulose (27.53%). Similar to present results variability in CP, NDF, ADF, OM and EE contents in the range of 6.6-11.0, 45.0-61.4, 31.6-54.2, 90.2-94.6 and 0.6-1.68%, respectively for different sorghum genotypes grown under different environments has been reported. Differences in CP and cell wall contents for stover, head and whole plants of sorghum hybrids has also been reported.

Structural (SC) and non structural carbohydrate (NSC) contents of the sorghum exotic accessions ranged between 57.92-72.61 and 10.67-26.21% with mean value of 67.78 and 21.43 %, respectively. Mean contents of slow degradable carbohydrate C_{B2} (56.44) was higher ($P<0.01$) than soluble sugar carbohydrate fraction C_A (24.61), rapidly degradable carbohydrate fraction C_{B1} (0.56) and indigestible/lignin bond carbohydrate fraction C_C (18.39%). However the concentration of C_A, C_{B1}, C_{B2} and C_C varied from 18.25-35.06, 0.334-0.819, 47.05-62.55 and 14.16-22.93%, respectively in the evaluated exotic accessions of sorghum. Carbohydrate accumulation in forage crops is influenced by several factors like plant species, variety, growth stage and environmental conditions during growth. Carbohydrate fractions for sorghum fodder reported by Das *et al.* (2015) are more or less identical to mean values of exotic accessions.

Mean contents of different protein fraction *viz.* Non protein nitrogen-P_A, rapidly degradable protein fraction-P_{B1}, moderately degradable protein fraction-P_{B2}, slowly degradable protein fraction-P_{B3} and undegradable/unavailable protein fraction PC were 15.36, 26.3, 35.71, 21.5 and 1.04 % of total protein in the exotic accessions of sorghum. The data on the protein fractions of stover from sorghum is limited, however the pattern of protein fraction contents is similar to the protein fractions values of forage crops reported earlier (Das *et al.*, 2015).

Total digestible nutrients (TDN), digestible energy (DE) and metabolisable energy (ME) contents of the exotic accessions varied from 47.56-60.55%, 2.1-2.67 K cal/g and 1.72-2.19 k cal/g, respectively. Variability in TDN contents for sorghum hybrids have been recorded (Singh and Shukla, 2010). A variability of 7.0 units in TDN contents in silage of sorghum

hybrids and mean TDN values (58.8 %) reported in a study lies within the range our values of TDN recorded for different accession.

Table 1. Mean and range values of nutritional attributes and methane production of different exotic sorghum accessions

Chemical composition (% DM)	**CP**	**OM**	**NDF**	**ADF**	**Cellulose**	**Lignin**	**EE**
	6.2 5.2-7.3	92.71 89.73-94.45	68.73 59.84-74.88	39.00 35.30-44.09	31.28 28.60-34.62	6.52 5.10-8.18	1.81 0.97-2.37
Carbohydrate (%DM) and fractions (% total carbohydrate	TCHO	SC	NSC	C_A	C_{B1}	C_{B2}	C_C
	85.04 80.66-91.84	66.36 57.92-72.61	15.93 10.67-26.21	24.61 18.25-35.06	0.56 0.334-0.819	56.44 47.05-62.55	18.39 14.16-22.93
Protein fraction (% CP)	SP	NPN	P_A	P_{B1}	P_{B2}	P_{B3}	P_C
	41.7 22.60-63.05	36.34 15.04-51.05	15.36 4.22-21.57	26.30 14.10-39.90	35.71 9.39-58.14	21.50 7.59-37.10	1.04 0.7-1.56
Energy efficiency (K cal/g) & CH_4 production (g/kg DDM)	TDN	DE	ME	NE_M	NE_L	NE_G	CH_4
	54.19 47.56-60.55	2.39 2.10-2.67	1.96 1.82-2.19	1.57 1.38-1.76	1.21 1.11-1.36	0.561 0.369-0.746	77.53 49.18-98.03

TCHO: Total carbohydrate (%DM); SP: Soluble protein (%CP), NPN: non protein nitrogen (%CP)

Net energy efficiency calculated values for different functions *viz.* NE_M, NE_L and NE_G varied between 1.38-1.76, 1.05-1.36 and 0.369-0.746 k cal/g, respectively. Studies on the net energy efficiency of sorghum hybrids for different animal production functions is limited, however some workers (Singh and Shukla, 2010) have reported net energy values of sorghum hybrids, corn silage and Sudan grass silage for different animal functions.

Methane production from exotic accessions of sorghum ranged from 49.18 to 98.79 with mean value of 77.53 g/ kg digested dry matter. Variability in methane production from 40.6-44.2 ml/g OMD and 41.8-46.4 ml/g OMD for brown mid rib and normal sorghum genotypes, respectively has been reported (Ouda *et al*., 2005) which confirms that hybrids differ in methane production potential depending on their chemical make and rate of nutrients degradability.

Conclusions

Results revealed that there is wide genetic variability in the exotic sorghum accessions for different nutritional traits and methane production which may be utilized in sorghum breeding strategies to develop nutritionally rich dual purpose sorghum cultivars.

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