

SHORT COMMUNICATION

Evaluation of two sorghum (*Sorghum bicolor* (L.) Moench) stover varieties as sole roughage source for dairy cattle

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Abstract: The present experiment was conducted to evaluate two popular sorghum stover varieties grown in parts of Karnataka and Maharashtra. The varieties are M35-1 (very old popular rabi jowar released for dry regions of Maharashtra) and PVK-1009 (Kharif Sorghum released for Maharashtra having more minerals). They have been subjected for chemical composition and *in vitro* studies using standard procedures. M35-1 has significantly higher CP ($P<0.05$) and Zn ($P<0.01$) than PVK-1009. ADF and cellulose were more ($P<0.05$) in PVK-1009 than M35-1. TA, NDF and HC were significantly higher ($P<0.01$) in PVK-1009. *In vitro* results were non-significant ($P>0.05$) except ME ($P<0.05$) which is greater in M35-1 variety. On the basis of present findings it is concluded that Rabi jowar variety M35-1 is nutritionally superior in CP, Zn and ME. However, Fiber fractions were higher in PVK-1009 and digestibility parameters (IVDMD, IVOMD) were comparable. Metabolizable energy (ME MJ/kg) was higher in M35-1 due to higher CP content. It can be concluded that both sorghum varieties (M35-1 and PVK-1009) were suitable for feeding livestock both Kharif and Rabi seasons.

Key words: Sorghum stover, Chemical composition, In vitro evaluation

Sorghum is an important rain-fed forage crop that provides staple food for the people in the semiarid tropics. In India, Sorghum grain which is cultivated during the rainy season is used for

livestock, while for human consumption sorghum grain which is cultivated during post-rainy season is used (Reddy, 2017). The crop residue (stover) after the harvest is a valuable source of fodder that has great potential to supplement fodder resources in dry parts of India like Andhra Pradesh, Karnataka and Maharashtra because of its wide adaptation, rapid growth, high green and dry fodder yields with high ratoonability and drought tolerance (Reddy et al. 2004). Sorghum (*Sorghum bicolor*) is also known as jowar in India, fifth most important cereal crop grown in the world. Sorghum is grown to an extent of 4.24 million hectares in India. Top five producing sorghums states in India are Maharashtra, Karnataka, Rajasthan, Tamil Nadu and Andhra Pradesh. The production of sorghum in India is to the tune of 4.78 million tonnes (Agricultural Statistics at a Glance 2021). With a straw to grain ratio of 1:2.5, the potential availability of sorghum stover works out to be 11.95 million tonnes. In other words, sorghum stover can alone fulfil roughage requirements of 3 million cattle annually. Sorghum is one of the oldest cultivated green forages for lactating animals (Iqbal, 2015). Importance of Sorghum occurs due to its drought resistant capacity and high yielding potential (Batog et al. 2020), heat tolerance (Chadalavada et al. 2021). Sorghum stover is preferred roughage source for dairy cattle and buffaloes in south after the grain harvest in southern states (House et al. 2000). The main objective of the current research was to evaluate the chemical composition and in-vitro digestibility between two popular sorghum varieties grown under field conditions for their suitability as dry fodder source.

M 35-1 is a popular rabi sorghum variety developed by selection from Maldandi population at Mohol, released for Maharashtra in 1969. It is tolerant to drought, shootfly and charcoal rot; known for bold and lustrous grains with good roti quality, and highly preferred for domestic consumption. It is popularly cultivated in Maharashtra, northern Karnataka and Telangana. The average grain yield is 15-18 q/ha, fodder yield is 50-60 q/ha with a duration of 120-125 days. The fodder is highly preferred by the cattle and visually having more greenness, stems pith and soft texture. 1 kg of straw sample has been procured from AICRP on Sorghum, ARS-Hagari District, Karnataka.

Parbhani Shakti (PVK 1009) is a kharif sorghum variety released for the state of Maharashtra in 2022. It is developed by selection

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from the germplasm line IS 26962-1 having marginally higher Fe and Zn content in the grains. The average grain yield is 38 q/ha and fodder yield is 111 q/ha with a duration of 115-118 days. The variety is moderately tolerant to grain mold and shoot fly. 1 kg of ground stover has been procured Sorghum Research station, Vasanthrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra.

The samples were ground in Cyclotec Mill (Foss) using 1 mm sieve without any external contamination. The samples were analyzed for proximate principles (AOAC, 2000) and fibre fractions (Van Soest et al. 1991).

About 1 g of feed sample was digested by 9 ml of tri acid mixture ($\text{HNO}_3:\text{HClO}_4:\text{H}_2\text{SO}_4$ - 3:2:1) in 100 ml Kjeldahl flask containing glass beads to avoid bumping at very low heat initially and then at high temperature till the contents clear and perchloric acid fumes ceases to come out. Then the digested sample was diluted with distilled water and filtered through Whatman filter paper No.42 and the final volume made up to 25 ml. The contents of different minerals in the samples were analyzed by using atomic absorption spectrophotometer (Shimadzu-7880). A stock solution containing 1000 ppm of Zn mineral was purchased from Merck chemicals. The operating parameters for estimation of Zn were: Zn hollow cathode lamp; Wavelength, 213.9 nm; slit width, 0.7 nm; lamp current 8.0 mA; vapor type, air/acetylene.

The rumen liquor was collected from the fistulated crossbred cattle before offer of feed and water in morning at experimental livestock unit of the institute in a double-walled (Thermos) flask flushed with CO_2 and maintained at 39°C in the incubator. The

rumen liquor was then strained with four layered muslin cloth and added (440 ml) to the buffer. The buffer was prepared by mixing 486 ml distilled water, 0.13 ml of micro minerals solution, 244 ml of rumen buffer solution, 244 ml of macro minerals solution, 1.26 ml of Resazurin solution and reducing solution 2.13 ml of 1N NaOH, 0.293g of Sodium sulfide and 49.3ml of distilled water (prepared fresh and added just before incubation). The medium mixture solution was pre-warmed to 39°C and bubbled with CO_2 just before addition to rumen liquor. Air equilibrated feed samples (200 ± 10 mg) were incubated in 100 ml calibrated syringes at 39°C for 24 h with 30 ml mixed rumen suspension containing rumen buffer and rumen liquor in ratio 2:1 (Menke and Steingass 1988) with parallel incubation of blank without feed sample. The syringes were shaken at every half an hour till 2 h and thereafter, every 2 h up to 8 h to initiate proper mixing of substrate with inoculum. Each sample was incubated in ten tubes over two independent runs. The total incubation period of 24 h was given and at the end of incubation, the level of the piston was again recorded. The total gas production during the incubation period was calculated by subtracting initial reading from final reading and correcting for corresponding blanks.

$$\text{Total Gas Production} \left(\frac{\text{ml}}{200\text{mg}} \right) \text{ in 24 hours} = (V - V_0 - G_0)$$

V = Reading after 24hr reading; V_0 = Reading after 1st reading; G_0 = Gas produced in blank syringes

To determine the substrate digestibility, contents of syringes after incubation were refluxed for 1 h with neutral detergent solution, filtered and oven dried at 60°C for 48 h to determine the in vitro dry matter digestibility (IVDMD). Subsequently, the

Table 1: Chemical composition of M35-1 and PVK-1009 varieties of sorghum stover

Variety	CP (%)	EE (%)	TA (%)	AIA (%)	Zn (mg/kg)
M35-1	5.93±0.12	0.40±0.14	5.49±0.03	2.51±0.05	12.3±0.16
PVK-1009	5.40±0.10	0.57±0.10	6.23±0.16	2.49±0.01	10.8±0.14
Significance	0.03	0.4	0.01	0.78	0.01
P Value	*	NS	**	NS	**

Each observation is a mean ± SE of three replicates (n=3)

** - Highly significant ($p < 0.01$); * - Significant ($p < 0.05$); NS – Non significant

Table 2: Comparison between fibre fractions of M35-1 and PVK-1009 varieties of sorghum stover

Variety	NDF (%)	ADF (%)	HC (%)	Cellulose (%)	ADL (%)
M35-1	62.7±0.11	42.6±0.82	20.1±0.94	34.0±0.97	8.61±0.15
PVK-1009	71.7±0.07	45.8±0.05	25.8±0.01	37.8±0.29	8.05±0.34
Significance	0.01	0.02	0.01	0.02	0.21
P Value	**	*	**	*	NS

Each observation is a mean ± SE of three replicates (n=3)

** - Highly significant ($p < 0.01$); * - Significant ($p < 0.05$); NS – Non significant

Table 3: Comparisons between In vitro digestibility parameters of M35-1 and PVK-1009 varieties of sorghum stover

Variety	TGP (ml/200 mg DM)	IVDMD (%)	IVOMD (%)	ME (MJ/kg DM)
M35-1	28.1±0.36	40.5±0.72	41.8±0.75	6.36±0.05
PVK-1009	27.5± 0.30	39.9± 0.37	41.3± 0.40	6.22± 0.04
Significance	0.24	0.49	0.58	0.04
P Value	NS	NS	NS	*

Each observation is a mean ± SE of 10 replicates (n=10)

* - Significant (p<0.05); NS – Non significant

residue obtained after double strength neutral detergent solution treatment were incinerated at 600°C for 3 h to estimate the In vitro true organic matter digestibility (IVOMD) and metabolizable energy (Menke and Steingass 1988) were calculated using formula.

$$ME = 2.2 + 0.136 GP + 0.057CP + 0.0029EE$$

Where:

ME=Metabolizable Energy (MJ/Kg DM); GP=Net Gas Production ml/200 mg substrate in 24 hours; CP= Crude Protein (%); EE=Ether Extract (%)

Analysis of variance (One-way) was performed (Snedecor and Cochran 1994) to find the significance of various test parameters. The results were considered statistically significant if the P-values were 0.05 or 0.01.

Cereal stovers and straws are usually low in crude protein and rich in fiber concentrations, unable even to meet the minimum CP requirements (7%) for maintenance of animals and rumen microbes (Minson 1990), so there is need to supplement these stovers with protein rich leguminous forage or non-protein nitrogen or protein sources. The chemical composition of the two stover varieties was shown in Table 1. CP content was significantly higher (P<0.05) in M35-1 (5.93) than in PVK-1009 (5.40). Similar to this, Singh et al. (2018) reported a range of 3.7 to 6.7 % in different cultivars of sorghum stover grown at Jhansi. EE was comparable between the two varieties. PVK-1009 was having greater (P<0.01) TA than M35-1 and no difference was observed in AIA among varieties. Zn content (mg/kg) was found to be higher (P<0.01) in M35-1 (12.3) compared to PVK-1009 (10.8). In contrast to our findings, Singh et al. (2018) reported much higher (28.6) Zn in PVK-809. Mineral concentrations in stovers can be influenced by various factors such as stage of harvesting, soil pH, climate, fertilizer and soil type etc. (McDowell et al. 1993).

Fibre fractions of the two stover varieties were shown in Table 2. NDF (P<0.01), ADF (P<0.05), HC (P<0.01) and Cellulose (P<0.05) were significantly higher in PVK-1009 than M35-1. Hamed et al. (2015) reported higher NDF (59-79) %, ADF (46-70) % and Lignin (9-13) % and stated that stover having least NDF and ADF percentage is considered to have better nutritive value.

In vitro digestibility parameters of M35-1 and PVK-1009 varieties of sorghum stover was presented in Table 3. In vitro evaluation

indicated that TGP, IVDMD, IVOMD and were non-significant except for ME which was higher (P<0.05) in M35-1 than PVK-1009. There is just an improvement of 0.5 % in IVDMD in M35-1 compared to PVK-1009 whereas Blümmel et al. (2010) reported almost 4-5 % improvement in digestibility of Rabi cultivated Stover (52%) compared to Kharif (47%). Our results conformed to the findings of Rao and Blummel (2010) who reported ME value of 6.19 (MJ/kg). In contrast to our present result, Kumar et al. (2011) and Singh et al. (2018) have reported a greater ME values. *In vitro* digestibility and ME were higher in M35-1 than PVK-1009. Sorghum and sudan grass species tend to be more digestible than corn. The plant growth environment can influence NDF digestibility. Generally, plants grown under cooler conditions or in northern latitudes have higher NDF digestibility than those grown further south or under hotter conditions. Within a growing season forages can change as well. Spring growth alfalfa tends to have higher fiber digestibility than alfalfa grown during the summer. Finally, crop management may influence fiber digestibility. For example, high corn plant density results in lower fiber digestibility.

Conclusion

Rabi jowar variety M35-1 is nutritionally superior in CP, Zn, and ME. However, Fiber fractions were higher in PVK-1009, and digestibility parameters were comparable between both varieties. So it is concluded that M35-1 and PVK-1009 were suitable for feeding livestock. Further, breeding programmes from sorghum quality improvement should consider including fodder quality parameters like CP, ADF and In vitro digestibility so as to realize high monetary value from the sale of stover.

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