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In vitro evaluation of *Dichanthium annulatum* (Marvel grass) grass hay diets supplemented with browse foliage

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ABSTRACT

In present study 20 *Dichanthium annulatum-DA* grass based diets formulated with browse foliage from 5 tree leaves (*Hardwickia binata*-HB, *Albizia lebbek*-AL, *Grewia optiva*-GO, *Anogeissus pendulla*-AP and *Leucaena leucocephala*-LL) and five shrubs (*Dichrostachys cineria*-DC, *Securengia virosa*-SV, *Zizyphus xylophyrus*-ZX, *Helictris isora*-HI *and Acacia catechu*-AC) in 50:50 and 75: 25 ratios were assessed for *in vitro* nutrients degradation, metabolites and gas production using sheep and goat rumen liquor. CP, NDF, ADF and cellulose contents differ significantly (P<0.05) amongst the diets. CP contents were higher in DA: LL (9.55) and DA: AL (8.58) diets and lowest in DA: HB diet (4.87%), while NDF, ADF and cellulose contents were higher in *DA: AL* (62.86, 42.09 and 32.82%) and lowest in DA: LL (55.15, 31.75 and 24.24 %). Mean values of DM, CP, NDF and ADF degradability varied significantly across diets in rumen inoculum of both species. DA: LL, DA: SV and DA: GO diets had higher DM, CP, NDF and ADF degradability in rumen liquor of both animal species. TVFA, total-N and ammonia-N contents were higher in sheep and goat from DA: LL, DA: SV and DA: GO diets. Sheep and goat rumen liquor had higher mean total-N contents at 50:50 ration of grass-foliage diets (45.36 and 47.57) than at 75: 25 ratio (36.00 and 36.96 mg/dl), respectively. Mean values of *IVDMD* (%), gas (ml/g) and partition factor differed across the diets in both species. Diets mean values for *IVDMD* and gas tended to be more for goats (167.50 and 54.13) than sheep (142.99 ml/g and 52.25%), while partition factor values tended to be more for sheep (3.58) than goats (3.01). DA: LL, DA: GO and DA: SV diets had higher gas and *IVDMD* in rumen liquor of both species and lowest for DA: DC diet. Results showed that DA: LL, DA: GO and DA: SV have higher nutrients digestibility with higher metabolites concentration on fermentation in sheep and goat rumen liquor.

Key words: *Dicanthium annulatum*, Gas production, *In vitro* evaluation, Shrubs/Tree foliage

Small ruminants are primarily reared by marginal farmers and landless people in rural areas through grazing on local grasses and browse foliage. Shrinkage of land for fodder production and further conversion of community lands and pastures for commercial activities has made the livestock production costly affair. Increased cost of protein and energy feeds restrict their use for feeding small ruminants and rearing of small ruminants on poor quality grasses, straws and stovers lead to loss in animal weight (Hindrichsen *et al*. 2004). Foliage rich in protein, mineral, soluble carbohydrate and vitamins (Njidda *et al.* 2013, Olafadehan 2013) provides an alternate to costly concentrates for improving nutrient utilization (Tolera 2007) and sustain production (Barakat *et al.* 2013). Tree leaves have the potential to bridge the gap between feed shortage and availability to some extent in lean supply dry season (Salem *et al*. 2006). Studies have proved that supplementation of foliage to poor quality grass hays, straws/stovers improved the intake, digestibility and production performance (Manaye *et al*. 2009). Therefore, in present scenario the use of browse foliages as protein feed is only the practical option to supplement the poor quality fodders and pastures for maintaining desired level of production. Keeping all these facts in mind, the study was proposed to assess the nutritive value of locally available foliage with available roughages to qualify as strategic supplement or sole feed to ruminants. *Dichanthium annulatum* (Marvel grass) originated from North Africa and India, is an excellent and widely used fodder grass appreciated by all classes of ruminants. In mixed pastures, marvel grass is preferred to all other grasses (Cook *et al*. 2005) and can be used in cut-and-carry system or for hay-making or silage making before flowering (FAO 2010, Cook *et al.* 2005). It can stand very heavy grazing and support up to 7 sheep/ ha in India. So, in present study *Dicanthium annulatum*- browse diets have been evaluated for *in vitro* nutrients degradability, fermentation, gas production and partition factors in sheep and goat inoculums.

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MATERIALS AND METHODS

Substrate and analytical techniques: Grass *Dichanthium annulatum*-DA, *trees* (*Hardwickia binata*-HB, *Albizia* *lebbek*-AL, *Grewia optiva*-GO, *Anogeissus pendulla*-AP and *Leucaena leucocephala*-LL) and shrubs (*Dichrostachys cineria*-DC, *Securengia virosa*-SV, *Zizyphus xylophyrus*-ZX, *Helictris isora*-HI *and Acacia catechu*-AC) on the basis of scientific feedback, yield potential, availability and use in feeding systems in Bundelkhand region were selected. Grass, tree leaves and shrubs samples were collected from the Institute grazing fields and nursery of Crop Improvement and Grassland and Silvipastoral Division. Samples of grass, tree leaves and shrubs were initially dried in shade on cemented floor and then in hot air oven at 60°C till a constant weight is achieved. The dried samples were ground to pass through 1 mm sieve using electrically operated Wiley mill and then stored in make plastic containers. Ground samples of grass and leaves from trees/shrubs were used for making 20 different diets in the ratio of 50:50 and 75:25, respectively.

Diets formulated with DA grass and leaves from shrubs/ trees in 50: 50 and 75:25 ratios were analyzed for ash, DM and CP (AOAC, 1995). Fiber fractions viz. NDF, ADF, cellulose and lignin of diets were estimated using sequential detergent method of Van Soest *et al*. (1991). To estimate the *in vitro* dry matter digestibility (*IVDMD*) of diets, 2 stage technique of Tilley and Terry (1963) was followed, while for the estimation of rumen metabolite concentration, single stage incubation *in vitro* technique was followed with. 0.5 g of substrate diets in triplicate using sheep and goat rumen liquor. After 48 h of incubation, the samples were filtered through sintered crucible and filtrate obtained was analyzed for total-N and ammonia-N and TVFA following methods of McKenzie and Wallace (1954), Convey *et al*. (1951) and Briggs *et al.* (1957), respectively. Gas production

Table 1. Chemical composition (% DM basis) of *Dichanthium annulatum* grass-browse foliage diets

Diets	OM	CP	NDF	ADF	Cellulose	Hemicellulose	Lignin
DA: AC 50: 50	91.35	8.05	52.21	30.89	21.77	21.32	7.09
DA: AC 75: 25	90.88	5.25	62.62	33.92	27.41	28.70	5.79
Mean	91.12	6.65	57.42	32.41	24.59	25.01	6.44
DA: ZX 50: 50	90.49	6.72	51.63	29.57	19.97	22.06	5.07
DA: ZX 75: 25	91.45	4.40	61.89	33.76	24.76	28.13	7.39
Mean	90.97	5.56	56.76	31.67	22.37	25.10	6.23
DA: HI 50: 50	89.70	6.56	54.94	31.31	24.06	23.63	6.61
DA: HI 75: 25	90.10	4.64	63.66	36.65	28.77	27.01	5.79
Mean	89.90	5.60	59.30	33.98	26.42	25.32	6.20
DA: SV 50: 50	89.98	6.40	50.05	27.93	23.23	22.12	3.80
DA: SV 75: 25	90.72	4.30	60.50	34.08	27.66	26.42	5.21
Mean	90.35	5.35	55.28	31.01	25.45	24.27	4.51
DA: DC 50: 50	90.71	7.70	56.29	31.76	21.44	24.53	8.86
DA: DC 75: 25	90.38	5.42	62.43	36.00	27.52	26.43	8.08
Mean	90.55	6.56	59.36	33.88	24.48	25.48	8.47
DA: LL 50: 50	90.31	11.80	49.85	28.51	20.82	21.34	6.52
DA: LL 75: 25	90.10	7.30	60.44	34.98	27.65	25.46	5.14
Mean	90.21	9.55	55.15	31.75	24.24	23.40	5.83
DA: AL 50: 50	91.73	10.15	59.25	34.57	24.53	24.68	8.78
DA: AL 75: 25	90.71	7.00	66.46	49.60	41.13	16.86	6.81
Mean	91.22	8.58	62.86	42.09	32.83	20.77	7.80
DA: HB 50: 50	91.02	5.62	54.81	33.31	24.48	21.50	7.72
DA: HB 75: 25	91.20	4.11	62.99	36.79	28.67	26.24	6.62
Mean	91.11	4.87	58.90	35.05	26.58	23.87	7.17
DA:AP 50: 50	91.45	9.90	55.27	29.75	22.41	25.52	5.98
DA:AP 75: 25	90.51	5.42	62.54	34.98	27.70	27.56	6.06
Mean	90.98	7.66	58.91	32.37	25.06	26.54	6.02
DA: GO 50: 50	89.70	6.12	51.80	30.25	23.80	21.55	5.58
DA: GO 75: 25	90.13	4.20	60.33	34.08	27.37	26.25	5.68
Mean	89.92	5.16	56.07	32.17	25.59	23.90	5.63
Mean ratio 50: 50	90.64	7.90	53.61	30.79	22.65	22.83	6.60
75: 25	90.62	5.20	62.39	36.48	28.86	25.91	6.26
SEM 50: 50	0.23	0.65	0.95	0.65	0.51	0.51	0.51
75: 25	0.15	0.36	0.58	1.50	1.41	1.05	0.30
Diets mean	90.60	6.55	58.04	33.72	25.84	24.32	6.43
SEM	0.18	0.62	1.35	1.35	1.28	0.78	0.18
Diets	NS	*	*	*	*	NS	*
Ratio	NS	*	*	*	*	NS	NS

*Differ significantly at P<0.05; NS-Nonsignificant.

and DM degradability of diets were estimated using pressure transducer technique of Theodorou *et al*. (1994). Diets were incubated for 24 h in bottles using rumen inoculums from sheep and goat. Residue left after incubation was analyzed for CP, NDF and ADF and the loss in these nutrients post incubation in sheep and goat inoculums was used to calculate their degradability for respective animal species. Partitioning factor was calculated with some modification as the ratio of mg of DDM to ml of gas produced (Blümmel and Lebzien 2001).

Statistical analysis: Data on nutritional composition, gas production, nutrients degradability and methane production were analyzed statistically using SPSS 13.0. Test of significance within diets and grass-foliage ratios was done using F test.

RESULTS AND DISCUSSION

Chemical composition: Crude protein, NDF, ADF and cellulose differ (P<0.05) among the diets (Table 1). Mean CP content was higher in DA: LL (9.55 % DM) and DA:

Table 2.Nutrients degradability (%) of *Dichanthium annulatum*-browse foliage diets in sheep and goat inoculums

	Sheep				Goat			
Diets	DM	CP	NDF	ADF	DM	CP	NDF	ADF
DA: AC 50: 50	52.0	48.1	41.6	31.2	56.8	49.4	39.1	34.7
DA: AC 75: 25	58.2	54.2	49.0	44.4	57.8	52.9	46.5	40.0
Mean	55.10	51.15	45.30	37.80	57.30	51.15	42.80	37.35
DA: ZX 50: 50	57.4	57.5	45.0	34.5	56.8	56.2	44.9	40.0
DA: ZX 75: 25	57.3	54.8	47.2	33.8	59.6	54.2	47.4	42.1
Mean	57.35	56.15	46.10	34.15	58.20	55.20	46.15	41.05
DA: HI 50: 50	71.6	64.3	57.6	48.6	70.0	68.2	57.6	54.4
DA: HI 75: 25	68.3	60.5	60.2	54.1	65.1	61.1	56.9	51.3
Mean	69.95	62.40	58.90	51.35	67.55	64.65	57.25	52.85
DA: SV 50: 50	74.1	72.2	50.0	40.5	73.2	78.4	51.3	50.3
DA: SV 75: 25	69.8	63.6	56.4	43.9	68.5	65.1	54.9	50.9
Mean	71.95	67.90	53.20	42.20	70.85	71.75	53.10	50.60
DA: DC 50: 50	49.7	50.9	33.8	27.8	50.9	52.4	46.3	40.6
DA: DC 75: 25	64.9	54.8	43.4	39.5	60.3	56.6	47.1	41.8
Mean	57.30	52.85	38.60	33.65	55.60	54.50	46.70	41.20
DA: LL 50: 50	67.7	75.0	54.9	49.4	69.6	77.9	57.2	52.6
DA: LL 75: 25	66.3	73.9	57.3	52.8	63.4	74.5	56.5	53.9
Mean	67.00	74.45	56.10	51.10	66.50	76.20	56.85	53.25
DA: AL 50: 50	65.3	71.4	48.5	39.3	59.5	72.6	49.2	41.4
DA: AL 75: 25	62.6	68.2	53.4	51.2	63.6	67.2	58.1	54.8
Mean	63.95	69.80	50.95	45.25	61.55	69.90	53.65	48.10
DA: HB 50: 50	52.8	52.7	44.3	39.9	61.5	55.9	43.8	39.8
DA: HB 75: 25	58.2	57.4	54.2	50.6	60.9	62.9	50.7	48.5
Mean	55.50	55.05	49.25	45.25	61.20	59.40	47.25	44.15
DA:AP 50: 50	52.0	68.5	47.4	37.2	57.4	66.4	49.1	41.5
DA:AP 75: 25	57.5	51.0	50.5	46.0	63.0	63.1	54.1	51.3
Mean	54.75	59.75	48.95	41.60	60.20	64.75	51.60	46.40
DA: GO 50: 50	77.0	75.6	62.8	59.1	67.0	76.3	52.9	50.2
DA: GO 75: 25	71.8	71.6	55.8	56.9	60.5	73.3	55.9	46.6
Mean	74.40	73.60	59.30	58.00	63.75	74.80	54.40	48.40
Mean ratio 50: 50	61.96	63.62	48.59	40.75	62.27	65.37	49.14	44.55
75: 25	63.49	61.00	52.74	47.32	62.27	63.09	52.81	48.12
SEM50: 50	3.27	3.32	2.64	2.96	2.30	3.50	1.86	2.11
75: 25	1.74	2.52	1.63	2.26	0.98	2.32	1.41	1.67
Diets mean	63.27	63.11	51.05	44.48	62.63	65.16	51.56	46.98
SEM	2.46	2.71	2.14	2.62	1.64	2.69	1.50	1.71
Ratio	NS	NS	*	*	NS	NS	NS	*
Diet	*	*	*	*	*	*	*	*

* Differ significantly at P<0.05; NS-Nonsignificant.

AL (8.58 % DM) diets and lowest in DA: HB diet (4.87%). Contrary to it NDF, ADF and cellulose contents were highest in DA: AL (62.86, 42.09 and 32.82 % DM) and lowest in DA: LL (55.15, 31.75 and 24.24 % DM). Diets with 50:50 ratio of DA grass- browse foliage had (P<0.05) higher CP and lower NDF, ADF and cellulose contents than diets with 75:25 ratio of grass- foliage. Differences in nutrient content of diets are due to differences in CP and fiber content of tree and shrub foliage. Variability in chemical composition of haylage (different grasses) and pumpkin foliage diets and basal diet of maize stover supplemented with *Erythrina variegate, Gliricidia sepium* and *Leucaena leucocephala* was reported (Aregheore 2007, Aregheore and Perera 2004). Differences in CP, fiber, OM contents of *Pennisetum purpureum* based diets supplemented with different tree leaves (Isah *et al.* 2013, Osakwe *and Udeogu* 2007) further substantiates our results.

Nutrients degradability: Mean degradability (%) values of DM, CP, NDF and ADF differed significantly (P<.0.05) (Table 2) in rumen inoculum of both species; however, the extent of nutrients degradation was at par between animal species. DM, CP, NDF and ADF degradability values were higher (P<0.05) for DA: LL, DA: SV and DA: GO diets both in sheep and goats and lower for DA: DC, DA: AC and DA: HB diets. Mean CP degradability values tended to be more in sheep and goats at 50:50 (63.62 and 65.37) ratio of grass: foliage diets, while NDF and ADF degradability was more (52.74 and 47.32 and 52.81 and 48.12 %) at 75:25 ratio, respectively. Aregheore and Perera (2004) recorded no differences in nutrients digestibility of maize stover based diet supplemented with *Erythrina variegate, Gliricidia sepium* and *Leucaena leucocephala* foliage. Rhode grass diet supplemented with 450g air dried moringa leaves (Gebregiorgis *et al*. 2012) had identical digestibility values of CP, NDF and ADF in sheep to present values. Sheep fed natural pasture grass hay *ad lib* supplemented with 150, 300, 450 g dried *Millettia ferruginea* leaf has DM, CP, NDF and ADF digestibility (Alemu *et al.* 2014) similar to present results. Basal diets of maize stover and *Pennisetum purpureum* supplemented with different tree leaves had different level of nutrients digestibility in sheep and goats (Ondiek *et al*. 2013, Isah *et al.* 2013) supports the present results. In another study Molina *et al.* (2000) recorded no significant differences (*P*<0.05) in nutrients and energy digestibility between goats and sheep fed alfaalfa hay-sugar beet, alfa alfa hay and alfa alfa hay-sugar beet and oat grain medium quality diets, however, extent of DM, OM, CP, NDF and ADF digestibility was identical and similar between animal species like present observations.

Rumen fermentation/metabolites: Concentration of TVFA (meq/l), total-N and ammonia-N (mg/dl) differed significantly (P<0.05) from fermentation of diets in rumen liquor of sheep and goat (Table 3), however the mean concentration of these metabolites was at par in rumen inoculum of both species. Concentration of TVFA, total-N

Table 3. Total volatile fatty acids (TVFA meq/l) and nitrogen metabolites (mg/dl) production from *Dichanthium annulatum*-browse diets in sheep and goat inoculums

	Sheep			Goat		
Diets	TVFA	Total-N	NH_3-N	TVFA	Total-N	NH_3-N
DA: AC 50: 50	58.0	42.0	10.8	60.0	44.8	11.2
DA: AC 75: 25	65.0	33.6	7.7	72.0	36.4	8.4
Mean	61.50	37.80	9.25	66.00	40.60	9.80
DA: ZX 50: 50	60.0	44.8	10.8	56.0	44.8	10.8
DA: ZX 75: 25	78.0	36.4	8.4	76.0	36.4	8.4
Mean	69.00	40.60	9.60	66.00	40.60	9.60
DA: HI 50: 50	67.0	42.0	9.8	72.0	44.8	10.0
DA: HI 75: 25	75.0	33.6	7.7	69.0	36.4	8.4
Mean	71.00	37.80	8.75	70.50	40.60	9.20
DA: SV 50: 50	80.0	44.8	10.8	87.0	47.3	11.2
DA: SV 75: 25	69.0	36.4	8.4	78.0	39.2	8.4
Mean	74.50	40.60	9.60	82.50	43.25	9.80
DA: DC 50: 50	63.0	44.8	10.5	68.0	47.6	10.5
DA: DC 75: 25	68.0	33.6	7.7	64.0	33.6	7.7
Mean	65.50	39.20	9.10	66.00	40.60	9.10
DA: LL 50: 50	89.0	50.4	11.2	93.0	50.4	11.9
DA: LL 75: 25	71.0	49.2	8.4	80.0	42.0	9.8
Mean	80.00	49.80	9.80	86.50	46.20	10.85
DA: AL 50: 50	69.0	47.6	10.5	76.0	50.4	11.2
DA: AL 75: 25	76.0	33.6	7.7	68.0	33.6	8.4
Mean	72.50	40.60	9.10	72.00	42.00	9.80
DA: HB 50: 50	55.0	39.2	9.8	75.0	42.0	10.2
DA: HB 75: 25	70.0	30.8	7.7	67.0	33.6	7.7
Mean	62.50	35.00	8.75	71.00	37.80	8.95
DA:AP 50: 50	61.0	47.6	10.5	76.0	50.4	11.2
DA:AP 75: 25	70.0	33.6	8.4	70.0	39.2	9.8
Mean	65.50	40.60	9.45	73.00	44.80	10.50
DA: GO 50: 50	77.0	50.4	11.2	72.0	53.2	11.9
DA: GO 75: 25	68.0	39.2	8.4	65.0	39.2	8.4
Mean	72.50	44.80	9.80	68.50	46.20	10.15
Mean ratio 50: 50	67.90	45.36	10.59	73.50	47.57	11.01
75: 25	71.00	36.00	8.05	70.90	36.96	8.54
SEM 50: 50	3.46	1.17	0.15	3.50	1.10	0.20
75: 25	1.29	1.64	0.12	1.74	0.91	0.23
Diets mean	70.02	40.89	9.33	72.64	42.38	9.77
SEM	2.29	1.83	0.35	2.51	1.70	0.38
Ratio	NS	*	NS	NS	*	NS
Diet	*	*	NS	*	*	NS

*Differ significantly at P<0.05; NS-Non-significant.

and ammonia-N was higher ($P<0.05$) both in sheep and goat from DA: LL, DA: SV and DA: GO diets and lowest from DA: HB diet (62.50, 35.00 & 8.75 and 71.00, 37.80 and 8.95), respectively. Mean total-N contents were higher ($P<0.05$) in rumen inoculum of both sheep and goats at 50:50 ration of grass-foliage diets (45.36 and 47.57) than at 75: 25 ratio (36.00 and 36.96 mg/dl), respectively. NH_3-N concentration in goats rumen liquor fed maize stover supplemented with different tree foliage (*Balanitesa egyptiaca* and *Acacia tortilis)* recorded by Ondiek *et al.* (2013) was relatively low than present values. On the other hand Isah *et al.* (2013) recorded higher NH_3-N concentration on *Pennisetum purpureum* diets supplemented with different tree leaves in goats and dietary differences were nonsignificant. Concentration of TVFA and NH_3-N observed by Osakwe and Steingass (2013) in rumen liquor of African Dwarf sheep fed grass hay supplemented with *Dialium guineense* leaves is at par to our values. Alemu *et al.* (2014) observed relatively lower NH_3-N contents in Washera sheep fed natural pasture grass hay supplemented with various levels of *Millettia ferruginea* (Birbra) foliage. These workers also recorded difference ($P<0.05$) in concentration of NH3-N between diets due to foliage supplementation and diets with more proportion of foliage had higher NH_3-N concentration like the present observations.

In vitro dry matter digestibility, gas production and partition factor: Mean values of *IVDMD* (%), gas production (ml/g) and partition factor differed ($P<0.05$) across the diets in both species (Table 4). Values of gas production and *IVDMD* tended to be more for goats (167.50 and 54.13) than sheep (142.99 ml/g and 52.25%), while partition factor tended to be more for sheep (3.58) than goats (3.01). DA grass-foliage ratios has no effect on these parameters in both species except the gas production was higher in goats at 75:25 (177.92) than 50: 50 ratio (157.72 ml/g). Gas and *IVDMD* values in both species inoculum were higher for DA: LL, DA: GO and DA: SV and lowest for DA: DC diet. Purcell *et al*. (2012) reported *IVDMD* and gas production values in the range of 51–85% and 122–196 ml/g for different foliage and grass are consistent to our values. Ouda *et al.* (2006) reported *IVDMD*, gas production and partition factor in the range of 53.3–67.9 %, 160.4–216.6 and 3.13–3.62for different dietary combinations of *Lespedeza cuneata* with maize stover and dry grass hay are consistent to our findings. Sheep fed maize stover supplemented with different multipurpose trees had degradability varying between 490 to 518 g/kg (Hindrichsen *et al*. 2004) which supports *IVDMD* values recorded in present study.

Findings of present study showed that diets consisting *Dichanthium annulatum* grass with SV, LL and GO foliage in their 50:50 and 75:25 ratios are nutritionally better for nutrients content and their degradability and metabolites production in rumen inoculum of both sheep and goats and thus can be utilized in silvipasture systems for sustainable ruminant production.

Table 4. *In vitro* dry matter digestibility and gas production from *Dichanthium annulatum* grass- foliage diets in sheep goat rumen inoculum

Diets	Goats			Sheep		
	IVDMD %	Gas (ml/g)	Partition factor	*IVDMD* %	Gas (ml/g)	Partition factor
DA: AC 50: 50	52.1	161	3.11	49.3	119.17	4.20
DA: AC 75: 25	51.9	183.5	2.72	52.7	160	3.13
Mean	52.00	172.25	2.90	51.00	139.59	3.58
DA: ZX 50: 50	54.2	161	3.11	52.7	127.1	3.93
DA: ZX 75: 25	53	176.3	2.84	50.3	142.3	3.51
Mean	53.60	168.65	2.96	51.50	134.70	3.71
DA: HI 50: 50	58.2	173.5	2.88	56.4	163.7	3.05
DA: HI 75: 25	53.1	185.8	2.69	54.3	153.6	3.26
Mean	55.65	179.65	2.78	55.35	158.65	3.15
DA: SV 50: 50	60.1	179.6	2.78	57.9	171.8	2.91
DA: SV 75: 25	54.7	189.1	2.64	55.8	170	2.94
Mean	57.40	184.35	2.71	56.85	170.90	2.93
DA: DC 50: 50	46.2	134.3	3.72	44.3	114.2	4.38
DA: DC 75: 25	50.1	166.6	3.00	47.3	145.3	3.44
Mean	48.15	150.45	3.32	45.80	129.75	3.85
DA: LL 50: 50	61.2	165.2	3.03	58	156.3	3.20
DA: LL 75: 25	59.7	175.3	2.85	57.1	157.3	3.18
Mean	60.45	170.25	2.94	57.55	156.80	3.19
DA: AL 50: 50	47.2	139.3	3.59	42.1	139.3	3.59
DA: AL 75: 25	51.2	172.3	2.90	45.7	145.5	3.44
Mean	49.20	155.80	3.21	43.90	142.40	3.51
DA: HB 50: 50	53.1	150.2	3.33	49.3	125.5	3.98
DA: HB 75: 25	51	173.7	2.88	52.4	136.5	3.66
Mean	52.05	161.95	3.09	50.85	131.00	3.82
DA:AP 50: 50	50.1	144.8	3.45	48.3	85.8	5.83
DA:AP 75: 25	54	166.1	3.01	53.2	121.6	4.11
Mean	52.05	155.45	3.22	50.75	103.70	4.82
DA: GO 50: 50	60.7	168.3	2.97	60.1	162	3.09
DA: GO 75: 25	57.9	190.5	2.62	56.2	158.3	3.16
Mean	59.30	179.40	2.79	58.15	160.15	3.12
Mean ratio 50:50	54.31	157.72	3.20	51.84	136.49	3.82
75:25	53.66	177.92	2.82	52.50	149.04	3.38
SEM 50:50	1.76	4.75	0.099	1.95	8.57	0.277
75:25	0.97	2.80	0.044	1.19	4.37	0.106
Mean diet	54.13	167.50	3.01	52.25	142.99	3.58
SEM	1.37	4.59	0.08	1.58	6.59	0.20
Diets	*	*	*	*	*	*
Ratio	NS	*	NS	NS	NS	NS

* Differ significantly at $P<0.05$; NS-Non-significant, Partition factor (mg DDM/ml gas).

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