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Feed resources and nutritional status of Malnad Gidda cows in the native tract of western Ghats of Karnataka: a case study

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Abstract
A study was conducted to assess the forage and grazing resources and intake of Malnad Gidda (MG); dwarf breed cattle in native tract of western Ghats, Karnataka. Forage consumption under grazing and microbial protein (MBP) production in rumen of 8 elite MG cows was studied. Malnad Gidda cows grazed on 6 species of grasses, 3 mixed grasses and 17 herbs in terrains areas. Crude protein contents in fresh grasses, including *karada* (mixed grasses) and dried roughage were ranged from 4.35 to 11.12% and 3.26 to 3.71%, respectively. Crude protein content of herbages was ranged from 7 to 17% except in *Guadua angustifolia* (Bambusa soppu; 3.46%). Dry matter intake (DMI) was 140 g/kg $W^{0.75}$ which was 4.5% of the total body weight and included 480 g of cottonseed meal and 735 g of dry roughage. Crude protein intake was 366 g/d. Energy efficiency was only 35%. Heat increment (HI) was 70% of metabolizable energy. Mean MBP flow was 86 g/d and proportionate to body size. Study concluded that dwarf breed MG cows were sustainable on diets with 8% CP because of less maintenance requirements with MBP production in rumen of 2.5 g/kg $W^{0.75}$, which was comparable to the other dairy breeds.

Keywords: Composition, Digestibility, Dwarf breed, Energy, Grasses, Protein, Sustainable

Abbreviations: ADF: Acid detergent fiber; **ADL:** Acid detergent lignin: **CC:** Cell contents; **CP:** Crude protein; **DCP:** Digestible crude protein; **DM:** Dry matter; **DMI:** DM intake; **EE:** Ether extract; **HC:** Hemicelluloses; **MBP**: Rumen microbial protein; **NDF**: Neutral detergent fiber; **NFC**: Non fibrous carbohydrates; **OM:** Organic matter; **PD:** Purine derivatives**; TCHO:** Total carbohydrates; **TDN:** Total digestible nutrients

Introduction

Malnad Gidda (MG) cattle are dwarf breed cattle native to western Ghats of Karnataka. Malnad Gidda cattle were synonym to their native tract *Male* (Rain), *nadu* (place) and *gidda* (short). Malnad Gidda cattle are playing a pivotal role in the rural livelihood of farmers of the region spread over in Shimoga, Chikmaglur, Udupi, Mangalore and in north Canara districts of Karnataka in terms of draught, milk and manure apart from auspicious faith. The average daily milk yield of elite cows is 2.11 kg with lactation length of 8.95±0.40 months (Singh *et al.,* 2008). Feed requirement for maintenance in this dwarf breeds was much lesser because of smaller body weight (BW) and size than medium or large dairy breeds (Srinivas and Ramesha, 2014). Concentrate supplements (CS) are offered in some farms in the early stage of lactation (Singh *et al.,* 2008). Breakeven point of milk production to compensate inflexible maintenance costs in MG cows is just 2 kg/d and above which profit margins from milk production was greater than medium or large size indigenous or crossbred cows (Srinivas and Ramesha, 2014). Malnad Gidda cows are appropriate breed of dairy cows that suits contemporary concept of sustainability because of their minimal resource demand. Although MG cows are reared by grazing, to our best of knowledge no systematic studies were conducted on their grazing based conventional system of rearing. Hence, this study was conducted to assess the feeding practices, grazing resources and intake of MG cows under conventional systems of rearing in their native tract.

Materials and Methods

***Study area*:** Study was under taken in the Malnad region located in the western and eastern slope of western Ghats of mountain region of Karnataka (Longitude 72.5° E and 75.5° E, Latitude 11.5° N and 14.5° N), India. Ghats in these regions are evergreen and semi-evergreen rich forests constitute the core of the region. Rainfall ranged from 1031 mm in Hasan to 4119 mm in Udupi districts. Anegoli, Sasarvalli, Karikoppa and Harekoppa agency areas of the region were selected. The soils are generally dark brown to dark reddish brown and black in colour due to accumulation of high organic matter under the

forest cover. These are lateritic soils having physiograhy of gentle sloping plains, summits of plateau and steeply sloping lands of western Ghats.

***Floral diversity*:** Ecological integrity and balance in the native tract of MG cows consist of wild range grasses, aromatic and medicinal plants, shrubs and trees. Paddy is grown as main crop in high rainfall areas e.g., Kodagu, Chikamagalur, Shivamoga etc. Coconut, areca nut, mango, cocoa, papaya crops are grown as pure orchards or mixed crops. Majority of trees are Silver oak, Acrocarpus, Teak, Honne etc. This region is also habitat for many medicinal and aromatic plants for e.g., Lemon grass (*Cymbopogan flexuous*), Bellente gidda (*Mussaenda belilla*), Indian kino (*Pterocarpus marsupium*), Yedumuri (*Helicteres isora*), mathi (*Terminalia tomantosa*), Ankole (*Alangium salvifolium*) etc.

***Feed intake and chemical analysis*:** Eight MG cows (mean age 44.8 ± 0.9 months; mean BW 108 ± 0.5 kg) were selected for the study in different periods from December to March in the year 2013-14. DM intake (DMI) and the fecal output were quantified by double indicator method (Srinivas and Swain, 2011). Chromic oxide (Cr_2O_3) was used as external marker to quantify the fecal output and, lignin as internal marker to estimate DMI. Cr_2O_3 concentration in the samples was estimated by colorimetric method by reading the absorbance at 430 nm using UV-visible spectrometer (M/s GBC Scientific Equipments Pvt. Ltd., Australia). Grazed feed samples by MG cows were collected from randomly clipping from the grazing spots. Cottonseed meal (CSM; CP, 32% and CF, 17%) of about 500 g was fed prior to leaving for grazing. Any one or two types (dry *karada* and paddy str--aws) of dry forages / roughages available were also after returning from the grazing. Fecal and feed samples were collected thrice at the beginning, middle and the end of each season. DMI was estimated from the lignin content in feed and feces. Feed and fecal samples were analyzed for proximate (AOAC, 2005) and cell wall (AOAC, 2005; Van Soest *et al.* 1991) constituents. Energy variables were derived using empirical models recommended by ARC (1980).

***Rumen microbial protein (MBP) production*:** Urine from each cow, about 50 ml/d, was collected in bucket acidified with 10% H_2SO_4 (v/v) for at least 3 days. Acidified sample of 100 ml urine was diluted uniformly to 1.2 L with distilled water (DW), thoroughly mixed, filtered through glass wool and 50 ml filtrate was collected in polypropylene bottles and kept at -20°C for further analysis. Purine derivatives (PD; allantoin and uric acid) excreted in urine was taken as markers to estimate rumen MBP. Urine volume was quantified based on creatinine (C) concentration. PD and creatinine in the urine samples were estimated using HPLC method (Aswin and Srinivas, 2015). Standards of allantoin, creatinine and uric acid were eluted at about 3, 4 and 8 min, respectively. Thawed urine sample were filtered through a membrane filter of 0.2µm pore size (M/s Sigman, Cat. No. F-1387) and 1 ml filtrate was collected, which immediately diluted by 10 folds with Millipore water after adjusting pH to 7 using either 0.01N NaOH or H_2SO_4. Urine samples (10 µl) neutralized for pH were injected to C18 reverse-phase column with 10mM potassium hydrogen phosphate (pH 4.7) as mobile phase with 1 ml/min flow rate and wavelength measured at 220 nm (Model 2489 UV Detector, M/s Waters India Pvt. Ltd., India). Elution time of PD and C in test samples was more or

Table 1. Proximate composition of forage resources used in rearing Malnad Gidda in native tract

Forage resources	Proximate principles (% dry matter basis)					
	DM	OM	CP	EE	TCHO	ASH
Chloris gayana (Rhodes grass)	20.00	92.46	04.35	02.98	85.13	07.54
Cynodon dactylon (Garike hullu)	32.08	91.32	10.42	04.21	76.69	08.68
Eleusine indica (Ganjalada hullu)	34.38	89.92	11.12	03.28	75.52	10.08
Pennisetum perpureum x *P.americarnum* (Hybrid Napier var. CO-3)	18.38	89.63	09.41	03.85	76.37	10.37
Megathyrsus maximus (Gini hullu)	23.35	91.60	07.12	02.03	82.45	08.40
Pennisetum purpureum (Ane hullu)	27.92	89.73	07.40	02.28	80.05	10.27
**Karada* 1, fresh grass early stage	15.71	95.36	09.21	02.89	83.26	04.64
**Karada* 2,fresh grass late stage	24.93	89.34	06.49	02.68	80.17	10.66
**Karada* 3, fresh grass mature stage	30.02	91.75	06.23	02.32	83.20	08.25
*Dry *Karada*	80.58	94.82	03.26	02.25	89.31	05.18
Paddy straw (*Oryza sativa*)	84.98	89.74	03.71	01.64	84.39	10.26

*Mix of wild perennial and seasonal grasses/herbs; All observations were average of 2 replicates those had SD (σ) less than 5%.

less similar to standards except little variation in uric acid. PD and C ratio was calculated. PDC index was derived based on the metabolic body weight. Endogenous PD contribution was taken as a constant at 0.147 $W^{0.75}$/d. Purine absorption and intestinal flow of MBP were calculated as suggested by Chen *et al.* (1995).

Statistical analysis: Data were analyzed for descriptive statistics. All the analyses were carried using statistical package for social sciences (V14.0).

Results and Discussion

***Forages*:** Forages grazed by MG cows and fed by the cattle owners were analyzed for proximate and cell wall composition (Table 1 & 2). Western Ghat is biologically richest region of the world where 1/3 flowering plants of India are found. The forest of Malnad area is less explored than other places in India. Malnad Gidda cows grazed on 6 species of grasses, 3 mixed grasses and 2 dry roughage sources in terrains areas near to villages. Ashwini *et al.* (2014) observed 73 grass species belongs to 43 genera in Bababudangiri and Kemmannugundi high land mountain hills of chikkamaguluru district, Karnataka. Studies conducted in Chikkamagaluru and Shivamogga districts reported only 9 and 19 species of grasses, respectively (Yoganarasimhan and Razi, 1981; Ramaswamy *et al.,* 2001). Crude protein contents in fresh grasses, including *karada* (mixed grasses) and dried roughage were varied from 4.35 to 11.12% and 3.26 and 3.71%, respectively. Dairy cow's protein utilization and efficiency is better when the total CP of the ration is not more than 12 %, compared to CP of 14 to 18 %. Beyond which nitrogen excretion in urine and dung increases linearly (Castillo *et al*., 2001). Grasses enlisted in table 1 were having moderate CP but good source of carbohydrates. Ether extract contents in grasses were ranged from 2 to 4%. Usually reproductive cyclicity in the dairy cows is predominantly influenced by the quantity of green fodder fed since plant oils are primarily consisting galactolipids and glycolipds rich in linolenic and α-linoleic acid.

***Shrubs and trees*:** MG cows were also grazed on shrubs and trees whose medicinal properties have been documented by EMPRI (2008). About 17 shrubs/trees were collected from the grazed areas of MG cows which were consumed at random during the observed period and also analyzed for proximate and cell composition (Table 3 & 4). CP content was ranged from 7 to 17% except in *Guadua angustifolia* (Bambusa soppu). They were also a moderate source of lipids and contained 1.5 to 6.5% but lesser in *Guadua angustifolia* and in the stem pith of *Musa acuminate* (Banana). Western Ghats in general and some districts in particular provide ideal habitat for these plants. Flavours of feed resources are sometimes transmitted to milk through the blood stream of the cow form the lungs or rumen (Rosetti *et al.,* 2010). Many owners rearing MG cows reported a characteristic flavour, colour and odour of their milk compared to cows reared under stall feeding. According to Danielsson *et al.* (2007) the medicinal and aromatic properties of shrubs/ trees grazed by MG cows might be transmitted into milk. Most of the shrubs are good source of minerals and secondary plant metabolites which show antioxidant properties.

Table 2. Cell wall composition of forage resources used in rearing Malnad Gidda in native tract

Forage resources	Attributes (% dry matter basis)						
	CC	NDF	HC	ADF	Cellulose	NFC	ADL
Chloris gayana (Rhodes grass)	33.93	66.07	30.67	35.40	31.55	51.20	03.85
Cynodon dactylon (Garike hullu)	35.87	64.13	16.08	48.08	41.45	40.82	06.63
Eleusine indica (Ganjalada hullu)	43.79	56.21	23.86	32.35	24.52	31.73	07.83
Pennisetum perpureum x *P.americarnum* (Hybrid Napier var. CO-3)	29.40	70.60	25.39	45.21	39.03	46.97	06.18
Megathyrsus maximus (Gini hullu)	27.66	72.34	27.91	44.43	33.09	54.79	11.34
Pennisetum purpureum (Ane hullu)	40.60	59.40	25.72	43.68	25.30	39.45	08.38
**Karada* 1, fresh grass early stage	25.47	74.53	30.27	44.26	37.42	57.79	06.84
**Karada* 2,fresh grass late stage	27.61	72.39	33.59	38.80	37.07	52.56	01.73
**Karada* 3, fresh grass mature stage	32.38	67.62	32.23	35.39	32.57	50.82	02.82
*Dry *Karada*	24.20	75.80	20.69	55.11	45.49	65.11	09.62
Paddy straw (*Oryza sativa*)	24.60	75.47	17.08	58.39	46.15	59.86	12.24

*Mix of wild perennial and seasonal grasses/herbs

All observations were average of 2 replicates those had SD (σ) less than 5%.

Table 3. Proximate composition of shrubs/tress used in rearing Malnad Gidda in native tract

Shrubs/trees	Proximate principles (% dry matter basis)					
	DM	OM	CP	EE	TCHO	Ash
Artocarpus heterophyllus (Jack fruit leaves)	33.85	91.13	11.07	04.06	76.00	08.87
Cyanotis tuberosa (Emme gadde)	16.07	93.95	12.58	01.56	79.81	06.05
Elephentopus scaber (Nelagonagalu)	10.00	77.77	14.88	02.63	70.26	12.23
Ficus glomerata (Athi)	20.81	85.29	08.60	05.56	71.13	14.71
Glyceridia Sepium (Gobbaradha gida)	21.61	91.23	16.96	04.37	69.90	08.77
Guadua angustifolia (Bambusa soppu)	37.66	90.60	03.46	01.51	85.63	09.40
Heletrix issora (Kaveri grass)	28.08	91.39	12.05	02.20	77.14	08.61
Hibiscus rosa-sinensis (Dasavala)	25.15	86.39	12.80	02.39	71.20	13.61
Holigrana grahamii (Halivwana)	17.34	92.00	12.97	04.54	74.49	08.00
Macuna pruriens (Monkay creaper)	17.79	96.71	09.96	03.22	83.53	03.29
Mimosa pudica (Touch me not)	30.35	95.86	12.96	06.47	76.43	04.14
Mimusops elengi (Bakula plant)	25.83	95.54	07.32	03.02	85.20	04.46
Musa acuminata (Banana stem pith)	06.58	85.39	11.27	00.94	73.18	14.61
Mussaenda belilla (Bellente gidda)	27.21	91.70	09.24	04.89	77.57	08.30
Pterocarpus marsupium (Honne tree)	29.65	82.61	11.69	03.68	67.24	17.39
Terminalia tomantosa, (Mathi tree)	29.92	95.89	08.02	02.12	85.75	04.11
Tinospora cordifolia (Amruthaballi)	26.68	93.53	11.41	02.91	79.21	06.47

All observations were average of 2 replicates those had SD (σ) less than 5%.

Table 4. Cell wall composition of shrubs/trees used in rearing Malnad Gidda in native tract

Shrubs / trees	Attributes (% dry matter basis)						
	CC	NDF	HC	ADF	Cellulose	NFC	ADL
Artocarpus heterophyllus (Jack fruit leaves)	37.69	62.31	17.94	44.37	30.26	38.31	14.11
Cyanotis tuberosa (Emme gadde)	26.76	73.24	57.77	15.47	12.50	53.05	02.97
Elephentopus scaber (Nelagonagalu)	47.48	52.52	22.46	30.06	14.09	22.78	15.16
Ficus glomerata (Athi)	48.69	51.31	20.23	31.08	08.25	22.44	22.80
Glyceridia Sepium (Gobbaradha gida)	49.07	50.93	12.63	38.30	21.98	20.83	16.32
Guadua angustifolia (Bambusa soppu)	25.80	74.20	25.76	48.44	42.14	59.83	06.32
Heletrix issora (Kaveri grass)	49.09	50.91	21.88	29.03	15.13	28.05	13.90
Hibiscus rosa-sinensis (Dasavala)	38.59	61.41	36.19	25.22	13.28	32.61	11.94
Holigrana grahamii (Halivwana)	36.55	63.45	24.81	38.64	20.29	37.94	18.35
Macuna pruriens (Monkay creaper)	36.42	63.58	21.55	42.03	29.74	47.11	12.29
Mimosa pudica (Touch me not)	43.96	56.04	22.70	33.34	20.95	32.47	12.39
Mimusops elengi (Bakula plant)	44.92	55.08	25.66	29.42	22.88	40.28	06.54
Musa acuminata (Banana stem pith)	43.29	56.71	32.83	23.88	18.02	29.89	05.86
Mussaenda belilla (Bellente gidda)	44.81	55.19	19.60	35.59	15.10	32.76	20.49
Pterocarpus marsupium (Honne tree)	46.35	53.65	24.65	29.00	15.05	20.89	13.95
Terminalia tomantosa, (Mathi tree)	47.93	52.07	19.23	32.84	14.23	37.82	18.61
Tinospora cordifolia (Amruthaballi)	31.91	68.09	29.41	38.68	32.52	47.30	06.16

All observations were average of 2 replicates those had SD (σ) less than 5%.

***Nutritional aspects of grazing*:** Dry matter intake **(**DMI) was 140 g/kg $W^{0.75}$, which was about 4.5% of the total body weight (Table 5). Conventionally DMI in cattle was drawn based on 2 to 4% the BW (Moran, 2005). However, subsequently energy needs were taken to determine DMI (NRC, 2001). DMI included 480 g of cotton seed meal and 735 g of dry roughages, thus mean graze was 3.24 kg per day. ARC (1980) suggested DMI of 183 g/kg $W^{0.75}$ in lactating Holstein Friesian cows. Crude protein intake was 366 g/d which was sufficient to produce 4 kg/d milk apart from meeting the maintenance needs. MG cows are sustaining and adapted to diet having 8.23% of CP. According to nutrient requirements for dairy cows, dietary CP requirement for early, mid and late lactation and dry cows was 15 to 18%, 14 to 16%, 12 to 14% and 10 to 12%, respectively (Moran, 2005). The better reproductive

Table 5. Nutritional status of grazing Malnad Gidda cattle

Attributes	Values	Attributes	Values
DM intake, kg/d	4.45±0.09	Metabolizable energy, Mcal	10.99±0.55
CP intake, g/d	366±6.78	Energy retention, Mcal	3.87±0.23
NDF intake, kg/d	2.90±0.06	Heat increment, Mcal	7.12±0.32
DM digestibility %	73.27±2.06	Energy efficiency, %	35.13±0.46
OM digestibility %	74.30±1.81	Total purine derivatives, mM/L	15.90±1.41
CP digestibility %	78.15±2.00	Total creatinine, mM/L	4.25±0.48
NDF digestibility %	70.93±3.85	PD : Creatinine ratio (PDC)	3.46±0.29
ADF digestibility %	66.70±2.07	PDC index	119.14±5.81
Cellulose digestibility %	63.15±2.53	PD excretion, mM/d	106.33±4.34
Digestible crude protein %	6.43±0.16	MBP, Duodenal flow, g/d	86.62±3.14
Total digestible nutrient %	68.45±1.51	Efficiency, g/kg DOMI	27.96±2.30

All observations were average of 8 animals.

ability of MG cows might be due to low levels of dietary CP. In a majority of the studies reviewed by Butler (1998), plasma progesterone concentrations in early lactation cows were higher when the dietary CP was lesser than 19-20%. Digestibility of DM or OM was near to 75%. Digestibility of different cell wall components ranged from 65 to 70% which was considered to be good. Their ingested diet consisted of more TDN than DCP which is well suited to physiological and adaptation needs of the region. Energy efficiency (35%) of MG cows under grazing was lesser compared to optimum range of 40 to 60% (ARC, 1980). The increase in energy requirement for grazing cattle is largely a function of distance walked, topography of the grazing lands and BW. Heat increment (HI) derived was 70% of the metabolizable energy which was more due to grazing in terrains. HI increases by 0.45 kcal/kg BW/km a cow walks horizontally and requires more when walks to the elevation.

Rumen microflora quantitatively is important in meeting the protein requirements of dairy cattle. PD excreted in the urine of ruminant animals comes predominantly from the metabolism of nucleic acids of microbial origin. C excretion was proportional to muscle mass and excretion was constant per metabolic BW. Mean MBP flow in MG cows under grazing was 86 g/d. To our best of knowledge, this study was first to quantify MBP production in miniature cattle. This indicated that the quantitative availability of MBP was more or less constant and probably related to size of the cow in general and rumen in particular. MBP production in crossbred cows was reported as low as 80 g/d to 270 g/d on straw diet without or with concentrate supplements, respectively (Srinivas and Gupta, 1997). The maximum MBP production of 217 g/d was reported in graded or crossbred cows on maize silage based diet and green forages (Srinivas and Krishnamoorthy, 2013). MBP production of 2.5 g/kg $W^{0.75}$ in MG cows was proportionate to the size and quantitatively comparable to metabolic body size of the other dairy breeds.

Conclusion

Study concluded that the DMI of the grazing Malnad Gidda cows was 4.5% of body weight which consisted partly from herbages having medicinal properties and CP intake of 366 g/d was sufficient to yield 4 kg of milk daily. Crude protein, DCP and TDN% of diet was 8.2, 6.4 and 68.5, respectively with 86 g/d of rumen MBP production that is sufficient to cater maintenance needs. Because of low maintenance needs, the nutritional requirement of Malnad Gidda cows was met/ found sustainable even with lesser feed resources and lower quantities of CP.

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