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Growth potential and nutrient utilization by non-descriptive goat kids of Hassan under intensive system

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Abstract
An experiment was conducted to assess the growth potentiality of non-descriptive goat kids reared in Hassan with COFS 29 as sole roughage source. Twenty non-descriptive goat kids of Hassan district aged 3-4 months and average body weight of 9.0±0.5 kg were selected and divided into four treatment groups with five replication and each one was randomly allotted to one of the four dietary treatments in a completely randomized design. COFS-29 was fed as a sole roughage source *ad libitum* to all the groups. Compounded feed mixture was offered to different treatment groups as to meet maintenance level (T_1) and to support body weight gains of 25 g/d (T_2), 75 g/d (T_3), and 125 g/d (T_4) as per ICAR, 2013. The experiment was carried out for the duration of 90 days and at the end of the feeding trial, eight experimental animals (two animals from each treatment group) were subjected to a metabolism trial for five days to assess the nutrient utilization. Body weight of the experimental animals was recorded at weekly interval during the feeding trial to determine body weight gain, average daily gain and feed conversion ratio of different experimental groups. The total dry matter intake (g/d) and R:C ratio was gradually improved from T_1 to T_4 group respectively without any adverse effects. Highest body weight gains was reported in T_4 group (73.55 g/d) fed to achieve 125 g gain/d. Positive nitrogen balance was noticed in all the treatment groups linearly in T_1 to T_4 group might be due to better crude protein intake and digestibility. Hence, it is concluded that the growth potentiality of non-descriptive goat kids reared in Hassan is 75 g gain per day when fed as per ICAR 2013 under intensive system.

Keywords: Growth potentiality, Hassan, intensive system, non-descriptive goat kids, digestibility

Introduction
Small ruminants are typically raised by landless or resource-poor farmers in rain-fed locations, where their average agricultural land holdings are either very small (marginal and small farmers) or insufficient to devote to crop cultivation (Kumar and Pant, 2003 and Singh *et al.*, 2005) [15, 1]. Further the average land holdings is gradually decreasing with 1.32 ha in 2000, 0.68 ha in 2010, and predicted to be just 0.32 ha in 2030 (ICAR Vision, 2030) [6]. Therefore most of the livestock reared on crop residues as such or by enriching it with urea to improve the quality of feed as the poor quality unconventional sugarcane trash when subjected for urea ammoniation improved digestibility of sugarcane trash as *in vitro* results showed increased metabolizable energy, truly digestible organic matter and microbial biomass production (Jaishankar *et al.*, 2018) [8]. Therefore the crop residues can be used efficiently for ruminants as roughage source. Goat rearing has proven that it is "the poor man's cow." Goats have a shorter generational gap than cattle, which allows them to reach higher levels of productivity in short time. They fit within the means of the low-income group due to their tiny size and relatively low individual price. The demand for goat meat is on the rise throughout the world, particularly in developing countries due to increased human population, rise in income and great need for lean meat (Sanon *et al.*, 2008) [22]. To meet this demand, there is a need to improve the productivity of goats, which is relatively low at present (Solomon *et al.*, 2008) [26]. Current production in India is low due to acute shortage of grazing land and browsing resources. Regardless of their good attributes, production of goats has decreased due to diseases, poor management and nutrition; nevertheless, there is ample scope for improving the productivity of goats through nutritional care and management.

In the present experiment, it was planned to assess the growth potentiality of non-descriptive goat kids reared in Hassan with COFS 29 as a sole roughage source.

Materials and Methods

Twenty non-descriptive goat kids of Hassan district aged 3-4 months with average body weight of 9.0±0.5 kg were selected and divided into four treatment groups with five replications and each one was randomly allotted to one of the four dietary treatments in a completely randomized design. Goat kids were fed to estimate dry matter intake with *ad libitum* COFS-29 as a sole roughage source and the goat kids were fed to meet nutrient requirement as per ICAR, 2013 to meet maintenance level (T_1) and to support gain of 25 g/d (T_2), 75 g/d (T_3), and 125 g/d (T_4) daily body weight gain. The daily allowance of compounded feed mixture (CFM) was weighed and offered twice a day at 12.00 PM and 4.00 PM. The leftover feed was recorded the next day at 9.30 AM. Clean drinking water was provided at free of choice to all the animals. Uniform managemental care like deworming, vaccination, etc., was given under stall-fed conditions. The experiment was carried out for the duration of 90 days at the Department of Animal Nutrition, Veterinary College Hassan in collaboration with Department of Livestock Farm Complex, Veterinary College, Hassan, Karnataka, KVAFSU, Bidar, India.

Metabolism trial, sample collection and chemical analysis

At the end of the feeding trial, eight experimental animals of comparable body weight (two animals from each treatment group) were subjected to a metabolism trial for five days to assess the nutrient utilization. The animals were provided adoption period for 3 days in the metabolic cage initially and then the metabolism trial was conducted. The feed offered and residue were weighed daily to determine the daily feed DM intake and the representative samples was taken and analyzed. The dung and urine voided from each animal was collected for 24 h to assess the nutrient digestibility of goats under different treatments. The pooled samples used for estimation of proximate principles as per AOAC (2005) [1] and fiber fractions as described by Van Soest *et al.* (1991) [9]. Body weight of the experimental animals was recorded before and after the metabolic trial.

Growth performance

All the experimental animals were weighed in the morning for two consecutive days before offering feed and water using digital balance weekly to determine body weight gain, average daily gain (ADG) and feed conversion ratio of different experimental groups.

Statistical analysis

The data of body weight, body weight gain, ADG, feed conversion ratio, DMI, various nutrient intake and digestibility of nutrients were analyzed statistically using analysis of variance technique. The data on feeding trial and metabolism trial was subjected to statistical analysis by one way ANOVA (Sheoran *et al.*, 1998) [24] and interpreted accordingly.

Results and Discussion

Chemical composition

The chemical composition (percent dry matter basis) of COFS-29 and compounded feed mixture (CFM) is presented in the Table 1. The chemical composition for COFS-29 were in accordance to Senthilkumar *et al.* (2009) [23] for crude protein (8.38%) and ether extract (2.62%) whereas Dombar *et al.* (2021) [5] reported similar results for dry matter (29.95%). Similar chemical composition was noticed by Ramchandra *et al.* (2002) [30] for sorghum stover for crude fiber (33.05%) and total ash (6.22%). The chemical composition of the COFS- 29 were found to be higher when compared to gram straw reported by Singh *et al.* (2020) [20] for CP and EE and were lower when compared to Napier grass by Khaing *et al.* (2015) [13]; Manjunath *et al.* (2014) [16] for crude protein (7.02), ether extract (3.01), crude fiber (22.8) whereas Kalyana *et al.* (2017) [12] noticed higher values for crude protein (12.42) and the untreated sugarcane trash had 3% CP whereas the urea ammoniated sugarcane trash has higher crude protein (11.98) as reported by Jaishankar *et al.*, (2017) [7] which can be comparable with COFS-29 fodder.

Table 1: Chemical composition (% DMB) of COFS-29 fodder and CFM used in the feeding trial

Proximate composition	COFS-29	Compounded feed mixture
DM	29.57	87.77
OM	93.36	93.72
CP	8.75	24.79
EE	2.34	3.67
CF	34.27	4.47
NFE	48.00	60.79
ASH	6.64	6.28
AIA	2.9	0.70

Body weight gain

The initial body weight (kg), final body weight (kg) and average body weight gain (g/d) of non-descriptive goat kids of Hassan are presented in the Table 2. Highest body weight gains was reported in T_4 group (73.55 g/d) fed to achieve 125 g gain/d. The improved gain might be due to increase in the CFM intake to achieve maximum gain and as better utilization of nutrients present in concentrates which helps the goat kids for better body weight gains. The results can be compared with the reports of Bhat and Khan, (2009) [2]. The average daily gain were found to be lower (66-69g/d) in Jamunapuri, Barbari, whereas Sirohi, Marwari and Kutchi noticed higher body weight gain (75-90 g/d) during 3-6 month aged goat kids under intensive system. The average daily gain was 86 g in Narisuwarna x Kenguri lambs at intensive system when fed urea ammoniated surgaecane trash as sole roughage source and concentrates to meet 100 g gain per day Jaishankar *et al.*, (2021) [9], which is higher when compared to body weight gains of goats. The findings of the present study were found similar to the Muktiani *et al.* (2003) [19] might be due to supplementation of higher level of crude protein. but higher gain than the present experiment was noticed by Khaing *et al.* (2015) [13] which may be due to feeding higher level of concentrate.

Table 2: Body weight and dry matter intake in non-descriptive goat kids of Hassan

Particular	T_1	T_2	T_3	T_4	SEM	*P value*
Body weight gain						
Initial body weight (kg)	9.25±0.49	9.24±0.45	9.26±0.49	9.25±0.39	0.456	NS
Final body weight (kg)	10.66±0.49^a	11.91±0.50^a	14.35±0.49^b	15.94±0.40^c	0.471	0.001
Average daily gain (g)	15.49±0.30^a	29.40±1.07^b	56.91±1.01^c	73.55±0.30^d	0.771	0.001
Total DMI						
(g/d)	304.51±2.56^a	329.58±3.47^b	384.89±4.01^c	413.69±1.54^d	3.044	0.001
% BW	3.06±0.12	3.10±0.15	3.22±0.12	3.23±0.08	0.12	NS
g/kg BW 0.75	54.31±1.53^a	55.85±2.03^{ab}	59.79±1.67^{bc}	60.91±1.13^c	1.621	0.032
Roughage DMI						
(g/d)	288.92±3.01^b	296.00±419^b	241.62±3.73^a	231.12±3.22^a	3.564	0.001
% BW	2.90±0.12^b	2.78±0.15^b	2.02±0.07^a	1.81±0.06^a	0.106	0.001
g/kg BW 0.75	51.51±1.42^b	50.11±2.22^b	37.43±1.01^a	34.05±0.93^a	1.484	0.001
Concentrate DMI						
(g/d)	15.57±1.23^a	33.60±2.53^b	143.26±3.31^c	182.57±3.39^d	2.757	0.001
% BW	0.16±0.02^a	0.32±0.01^b	1.21±0.06^c	1.42±0.04^d	0.035	0.001
g/kg BW 0.75	2.80±0.26^a	5.75±0.24^b	22.26±0.89^c	26.86±0.54^d	0.547	0.001

^{abc}Mean values in a row bearing different superscripts differ significantly ($p<0.05$)

Dry matter intake

The average total dry matter intake (DMI, g/day), total DMI expressed as percent of body weight and g/kg metabolic body weight of goat kids in different treatment groups are presented in Table 2. Total average dry matter was seen better in T_4 due to increase in amount of concentrate feed mixture proportion. But significantly lower DMI from roughage was observed as the proportion of CFM increased in the diets. Significantly higher DMI from CFM could not be avoided, as roughage and CFM were fed separately as per growth requirements and preferentially goat kids consumed complete CFM than roughage. The total dry matter intake in the present study was found similar to Khaing *et al.* (2015) [13]; Moniruzzaman *et al.* (2002) [18]; Kide *et al.* (2015) [14] under stall fed condition whereas higher intake dry matter intake was reported by Meel *et al.* (2018) [17] and Zhu *et al.* (2020) [28] which varied with the present study with varying proportion of body weight weekly at 125 g/d gain. The total dry matter intake (g/d), on % body weight and on metabolic body weight (g/kg $BW^{0.75}$) were significantly improved as increase in the supplementation of concentrates to meet expected daily gains. But significantly lower DMI from roughage was observed with the increased proportion of CFM in the diets as this could not be avoided as roughage and CFM were fed separately in NariSuwarna × Kenguri F1lambs (Jaishankar *et al.*, 2021) [9].

Nutrient Intake

The average OM, CP, EE, CF, NFE intakes of the experimental goat kids are presented in the Table 3. Highest OMI and CPI was found in T_4 group due to high intake of DM that increased linearly as CFM proportion was increased in the diet to meet the gains ICAR (2013). However there was no significant ($p<0.05$) difference between the groups of intake of EE, CF and NDF. Similar results were reported by Chanjula and Ngampongsai *et al.* (2008) [3] and Obeidat *et al.* (2010) [20] reported for higher OMI and CPI and Obeidat *et al.* (2010) [20] and Kide *et al.* (2015) [14] for EE, CF and NDF respectively when compared to the present study due to increase in the dry matter intake through concentrate than through roughage.

Table 3: Mean nutrient intake in non-descriptive goat kids of Hassan

Particulars	T_1	T_2	T_3	T_4	SEM	P value
OM (g/d)	292.2±19.12^a	309.6±8.23^a	371.2±12.30^b	409.1±13.78^b	13.91	0.001
% BW	2.72±0.18^a	2.62±0.07^a	2.61±0.09^a	3.37±0.11b	0.12	0.001
CP (g/d)	27.39±1.79^a	31.12±0.77^a	55.16±1.15^b	69.95±1.29^c	1.3	0.001
% BW	0.25±0.02^a	0.26±0.01^a	0.39±0.01^b	0.58±0.01^c	0.01	0.001
EE (g/d)	7.33±0.48^a	7.93±0.21^a	10.98±0.31^b	12.86±0.35^c	0.35	0.001
% BW	0.07±0.0^a	0.07±0.0^a	0.08±0.0^a	0.11±0.0^b	0.003	0.001
CF (g/d)	107.27±7.02	109.71±3.02	98.15±4.51	91.05±5.06	5.11	0.071
% BW	1.00±0.07^c	0.93±0.03b^c	0.69±0.03^a	0.75±0.04a^b	0.04	0.001
NFE (g/d)	150.24±9.83^a	160.83±4.23^a	206.87±6.32^b	235.22±7.09^c	7.15	0.001

^{abc}Mean values in a row bearing different superscripts differ significantly ($p<0.05$)

Digestibility of nutrients and Nitrogen balance

The digestibility of drymatter, nutrients and nitrogen balance during the metabolic trial is presented in the Table 4. The dry matter digestibility was better in T_4 group due to linearly increasing in proportion of CFM, since the digestibility of CFM is higher when compared to digestibility of roughage. Whereas, highest organic matter digestibility was noticed in T_2 & T_4 group because of the higher organic matter intake through concentrates supplemented to meet 125 g gain per day as per ICAR 2013. Better CP digestibility was noticed in T_2, T_3, and T_4 group when compared to T_1. This might be due to source and increase in the CFM intake to meet the requirements of body weight gain. Crude fibre digestibility was significantly higher in T-2, T-3 when compared to that of T_1 due to high amount of CFM intake that has less crude fibre and less lignified than roughage source. High crude protein intake in concentrate supplemented groups might have improved rumen microbial production and intern better rumen fermentation that contributed for better fibre digestibility. This increased intake is due to high levels of soluble nutrients present in CFM reflected in better NFE digestibility. Similar findings was reported by various authors by Obeidat *et al.*

(2010) [20], Chanjula and Ngampongsai *et al.* (2008) [3], Tona *et al.* (2014) [27] for DM, OM and CP whereas Kide *et al.* (2015) [14] noticed higher values for CF and NFE.

The *in vitro* gas production study also showed linear increase in gas production with increase in proportion of concentrates in the diet. This might be due to availability of better digestible nutrients from concentrates for rumen microbes. Truely digestible organic matter, Partitioning factor, microbial biomass production and efficient microbial biomass synthesis for complete diets increased linearly with increase in the proportion of CFM from 20 to 60 percent in the diet. The optimum microbial biomass indices were observed with 50% of sugarcane trash (SCT) and marginal reduction over 60% of SCT in diet was observed. Hence, it is recommended that SCT can be incorporated upto the level of 50% in complete diet for efficient utilization (Jaishankar *et al.*, 2021a) [10].

Nitrogen Balance

There was no significant (p>0.05) difference between T_1 and T_2 whereas T_3 and T_4 significantly (p<0.05) varied when compared to other treatment groups for nitrogen intake (g/d) however there was no significance (p>0.05) difference among T_2 and T_4. Whereas T_1 and T_3 significantly (p<0.05) varied when compared to other treatment groups for nitrogen outgo (g/d) and there was no significance (p>0.05) difference among T_2 and T_3 whereas T_1 and T_4 significantly (p<0.05) varied when compared to other treatment groups for nitrogen balance (g/d). Positive nitrogen balance was noticed in all the treatment groups linearly in T1 to T4 group due to better CPI which increased the nitrogen intake and better CP digestibility that contributed for better body weight gains. The nitrogen balance of the present study was accordance to Chanjula and Ngampongsai *et al.* (2008) [3]; Tosto *et al.* (2021) [5]; Zhu *et al.* (2020) [28]; de Carvalho *et al.* (2021) [4] as increase CP intake and digestibility reported positive nitrogen balance reflecting improved body weight gains.

Plane of Nutrition

The Plane of Nutrition and nutritive value of the diet used in the feeding trial is presented in the Table 5. All the parameters significantly (p<0.05) varied among treatment groups and T_4 noticed higher values for all the parameters due to higher digestibility of nutrients in concentrate supplements than roughage source. Similar results were reported as the DCP and ME intake was gradually increased when proportion of CFM in complete diet increased. This was due to better palatability of CFM than roughage and higher DCP and ME content of diet (Jaishankar *et al.*, 2021b) [11].

Table 4: Mean digestibility of nutrients and nitrogen balance in non-descriptive goat kids of Hassan

Digestibility %	T_1	T_2	T_3	T_4	SEM	*P value*
Dry matter	50.87±3.90^a	62.86±1.45^b	65.41±1.69^b	72.54±0.89^c	2.29	0.001
Organic matter	78.51±1.70^a	87.33±0.49^c	83.97±0.79^b	87.16±0.42^c	0.99	0.001
Crude protein	50.87±3.90^a	87.93±0.46^c	73.09±1.19^b	71.10±1.25^b	2.1	0.001
Ether extract	62.20±2.90^a	68.96±1.20^b	79.14±0.90^c	80.20±0.70^c	2	0.001
Crude fiber	65.69±2.72^a	75.46±0.97^b	71.18±1.60^b	70.78±0.72a^b	1.7	0.008
Nitrogen free extract	48.16±4.11^a	61.11±1.51^b	65.76±1.64^b	74.30±0.89^c	2.38	0.001
N-Balance						
N, intake (g/d)	4.38±0.29^a	4.98±0.12^a	8.83±0.18^b	11.19±0.21^c	0.21	0.001
N, total outgo (g/d)	3.61±0.16^b	1.42±0.13^a	4.52±0.24^c	5.69±0.20^a	0.19	0.001
Retained Nitrogen (g/d)	0.77±0.38^a	3.56±0.15^b	4.30±0.29^b	5.50±0.08^c	0.25	0.001

^{abc}Mean values in a row bearing different superscripts differ significantly (p<0.05)

Table 5: Mean nutritive value of the diet used in the feeding trail fed to non-descriptive goat kids of Hassan

Particulars	T_1	T_2	T_3	T_4	SEM	*P value*
DCP %	4.45±0.34^a	8.26±0.04^b	10.17±0.18^c	11.40±0.37^d	0.266	0.001
DOMD %	73.30±1.59^a	81.54±0.46^d	78.49±0.73^b	81.51±0.39^c	0.926	0.001
TDN %	4.72±0.35^a	8.55±0.04^b	10.41±0.18^c	11.62±0.37^d	0.27	0.001
DE (MJ/Kg DM)	0.87±0.07^a	1.58±0.01^b	1.92±0.03^c	2.14±0.07^d	0.15	0.001
ME* (MJ/Kg DM)	0.71±0.05^a	1.29±0.01^b	1.57±0.03^c	1.76±0.05^d	0.041	0.001
DCP intake (g/d)	14.19±0.03^a	27.37±0.01^b	40.33±0.04^c	49.68±0.09^d	0.05	0.001
ME intake (MJ/d)	0.23±0.01^a	0.43±0.00^b	0.62±0.00^c	0.77±0.01^d	0.005	0.001
TDN intake (kg)	15.03±2.14^a	28.35±0.78^b	41.28±1.23^c	50.64±0.62^d	1.331	0.001

^{abc}Mean values in a row bearing different superscripts differ significantly (p<0.05)

Conclusion

The overall performance of growing goat kids in terms of average daily gain, dry matter intake and nutrient digestibility from the study it was concluded that the growth potentiality of non-descriptive goat kids was 73.5 g/d, which was observed in the treatment group supplemented to gain 125 g/d (T4) as per ICAR 2013 under intensive system. The total dry matter intake (g/d) and R:C ratio was gradually improved from T_1 to T_4 group respectively without any adverse effects. Hence, COFS 29 fodder can be used as sole roughage source in goat kids for better performance. The higher benefit cost ratio was observed in T_3 and T_4 groups when compared to T_1 and T_2. Hence it is concluded and recommended to feed non-descriptive goat kids to achieve 75 g gain per day as per ICAR 2013 under intensive system with good management practice for better economic returns.

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