FEEDING EFFECTS OF MAIZE AND BARLEY HYDROPONIC FODDER ON DRY MATTER INTAKE, NUTRIENT DIGESTIBILITY AND BODY WEIGHT GAIN OF KONKAN KANYAL GOATS

Article · July 2015

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Abstract: This experiment was conducted to evaluate the effect of feeding hydroponically sprouted maize and barley fodder for Konkan Kanyal goats. The experiment was conducted at the Instructional livestock farm, College of Agriculture, Dapoli-415712, District Ratnagiri (M.S), India. Eighteen growing male kids of 3-7 months old with initial body weight of 11.01±0.26 kg were divided into six treatments (3 animals each) randomly to receive one of the treatment diets *viz*. T_0-Finger millet straw(FMS)100%; T_1- FMS + hydroponic maize fodder (HMF) 80%:20%; T_2-FMS + hydroponic barley fodder(HBF) 80%:20%; T_3-FMS + HMF 60%:40%; T_4-FMS + HBF 60%:40%; T_5-FMS + HMF + HBF 60%:20%:20% for 97 days. After adaptation to the experimental feed, digestibility trial of 7 days was conducted individually to evaluate digestibility of experimental feed and estimated body weight gain and feed conversion efficiency of the experimental fodder fed to growing goats. Results denoted a significant ($P < 0.05$) improvement in DM intake in T_5 (504.51 g/day) and T_3 (415.36 g/day) than control (317.54 g/day) and DM digestibility coefficient was highest in T_5 (68.44%) and T_3 (67.28%) while feed conversion efficiency in T_3 (12.15%) and T_5 (10.56%) was higher than T_0(-0.47%) and average body weight gain in T_3 (61.93g/day) and T_5 (56.70g/day) was significantly higher than T_0 (-1.17g/day). Therefore, it can be concluded that feeding of hydroponically sprouted maize and barley fodder to growing goats increased the digestibility of nutrients, body weight gain and feed conversion efficiency.

Keywords: Body weight, Digestibility, Feeding, Goats, Hydroponic fodder, FCE.

Introduction: Fodder production and livestock feeding are the two important aspects for the sustainability of products and productivity in animal husbandry [12]. India is short in concentrate feed (84%), green fodder (88%), infertile and limited land holding, deteriorated area under fodder cultivation and poor husbandry systems with imbalance feeding of total dry matter and nutrients intake causing inferior production [5]. In Konkan region, about 39% fodder is crop residue and the remaining 60% is bulk formed by grasses having low nutritive value. Feeding animals as per the requirement and avoiding wastage is the basic point in exploiting the production potential of livestock for economic growth and sustainability since feed costs are the dominant parts of production that accounts for 60-80% [12].So, supplementation of low quality roughages with hydroponic green fodder coming up as a practical approach for improving roughages utilization and digestibility. In India, limited researches has been done on feeding value of hydroponic fodder for livestock's [23], therefore, the study was conducted to identify the ″ Feeding effects of maize and barley hydroponic fodder on dry matter intake, nutrient digestibility and body weight gain of Konkan Kanyal Goats″

Materials and methods:

Fodder production, Animals selection and feeding management: Green fodder maize was produced at a hydroponic fodder production unit of 30.3 x 8.2 x 6.0 ft length, height and width, respectively with 0.4% slope for adequate removal of excess water at the Dairy farm, Agriculture College, Dapoli, District Ratnagiri (M.S)-India. The racks were prepared by using bamboo stands with three shelves (1 ft^2 distance each) with capacity of 120 plastic hydroponic trays, sized 1.8 ft length × 1.0 ft width × 0.15 ft height equipped with semi-automated sprayer irrigation. The trays with holes at the base were to allow drainage of excess water from irrigation. Water used was tap water free from any additives. The temperature and humidity inside the green house was controlled through micro-sprinklers irrigation to maintain a range of 22 - 270C temperature and 70-80% relative humidity. African tall Maize variety (Zea mays L.) and Barley (Hordium vulgari.L) were used and soaked for 12 hours in tap water. After 24-36 hours of germination in gunny bag, sprouted seeds were spread on the hydroponic tray at a rate of 500 gram for maize and 350 gram for barley per tray sized 1.8 ft^2 and 1.5-2 cm layer thickness. After eight days growing 8 kg maize and 9 kg barley hydroponic fodder were produced per kg of dry seed. The biomass and quality of hydroponic fodder was recorded daily before feeding the experimental animals. Eighteen healthy weaned Konkan Kanyal kids of 3 to 7 months of age were selected from the Instructional livestock farm, College of Agriculture, Dapoli and allocated to six treatments and three replications with comparable body weight of 11.01±0.26 kg using randomized block design experiment and kept for 90 days feeding trial and 7 days metabolic trial period. Kids were de-wormed using Ivermectin injection @1 ml/50 kg body weight and placed in well-ventilated pens disinfected with Cypermethrin-High Cis (0.5%) at the rate of 4 ml per 10 liter of water and surface sterilized using formaldehyde (5 %) for external parasite. A standard creep feed mixture by weight of Maize crumbs (50%), Rice bran (30%), Groundnut cake (10%), Jaggery (7%), Mineral mixture (2%) and Salt (1%) were prepared. The CP level was maintained at 15% and the animals were individually fed @200gm/day to cover their maintenance requirement besides to basal diet according to BIS standard. The animals were offered clean drinking water *ad-lib* throughout the 90 days feeding trial. The basal feeds and hydroponic fodder were offered in two equal parts at 8.30 A.M and 15.00 P.M. and feeding treatments were as follows.

T_0- Finger millet straw (100%) ; T_1- Finger millet straw + Hydroponic maize fodder (80%: 20%); T_2- Finger millet straw + Hydroponic barley fodder (80%: 20%); T_3- Finger millet straw + Hydroponic maize fodder (60%: 40%); T_4- Finger millet straw + Hydroponic barley fodder (60%: 40%); T_5- Finger millet straw + Hydroponic maize + Hydroponics barley fodder (60%: 20%:20%)

After preliminary feeding of 90 days, 7 days collection of faeces and urine was done using metabolic cages separately. Records of individual water offered, left over, faeces and urine excreted were maintained on 24 hours basis. Experimental feeds were sub- sampled to determine the nutrient composition of each 100g and oven-dried at 100 °C and ground to pass a 1-mm mesh screen sieve and analyzed nutrients content *viz* Dry Matter (DM), Crude Protein (CP), Ether extract (EE), Crude Fiber (CF) and Nitrogen free extract (NFE) as per [3]. Data were statistically analyzed by the Randomized Block Design, using General Linear Model (GLM) procedure of SAS [26] and the difference and interaction between treatments were tested for significance using least significance difference (LSD).

Results and discussion:

Chemical composition of experimental feeds: The chemical composition of finger millet straw was described (Table 1.) as DM (87.7%), CP (3.2%), EE (2.23%), CF (27.2%), NFE (53.77%) and higher DM% was reported by [15] as 93% and [1] as 92.5% in FMS but the CP% of FMS (3.2%) was lower than MHF(14.56%) and BHF(13.86%). Agreement results were pointed out by[29] as 11.38-24.9% and lower values of [9] as 13.72% in sprouted barley fodder and [20] as 13.30-13.6% and [28] as 13.57% in sprouted maize fodder while comparable result of CP% to FMS was reported by [1] as 3.6%.

Table1.Chemical composition of experimental feeds (% DM basis)

Items (%)	Experimental feeds			
	FMS	MHF	BHF	Cr.F
DM	87.7	18.25	13.64	92.06
CP	3.2	14.56	13.86	14.56
EE	2.23	4.67	5.67	5
CF	27.2	10	13.5	11.2
NFE	53.77	68.47	63.57	68.2

FMS: finger millet straw, MHF: maize hydroponic fodder, BHF: barley hydroponic fodder, CrF: creep feeds, DM: dry matter, CP: crude protein, EE: ether extract, CF: crude fiber, NFE: nitrogen free extract, %: per cent.

The ether extract content of the present finding was found as 5.67% in BHF, 4.67% in MHF and 2.23% in FMS and found superior to the reports of [8] and[25] as 3.86 and 3.72% in BHF while [20] as 3.27-3.50% in MHF and [30] as 1.96% in pearl millet straw. The crude fibre content of the current investigation was 13.5% (BHF), 10% (MHF) and 27.2% (FMS). The increase in CF content of hydroponic fodder might be due to the synthesis of structural carbohydrates such as cellulose and hemicelluloses[4] while the present value was comparable to the results of [2] in BHF as 13.2%, [20] in MHF as 6.37-14.10% and [22] in FMS as 27.48%, consecutively. The NFE value of BHF (63.57%) was higher than findings of [25] as 62.12% and [24] as 61.3% while value of MHF (66.47%) was in close agreement to the reports of [20] as 66.70-75.32% and NFE values of FMS (53.77%) was higher than values reported by [22] as 50.01% in untreated finger millet straw.

Dry matter intake, digestibility and feed conversion efficiency: The average daily DM intake was observed significantly higher ($P<0.05$) in T_5 (504.51) than T_0 (317.54) while remaining treatments were at par with each other. Higher values of daily DM intake (g/day) observed in treatment group T_5 may be due to the higher palatability for mixed maize and barley hydroponic fodder fed to growing goats followed by the hydroponic maize fodder (T_1 and T_3), hydroponic barley fodder (T_2 and T_4) than control group T_0(Finger millet straw).Daily feed intake revealed, the animals consumed the entire mat, roots and green shoots since the sprout mat is completely edible and highly nutritious as it is a living food and no waste at all. Similar results were reported by [15] as the higher DM intake observed could be due to the high palatability of hydroponic barley fodder fed by Awassi ewes and superior to [1] in male lambs fed 300 g DMI/day finger millet straw mixed with noug seed cake; [9] in male calves fed 6.6 and 7.2 kg DMI/day as control and substituted 22.8% barley hydroponic fodder. The present findings of intake per 100 kg BW (kg) was significantly ($P<0.05$) higher in T_5 (3.33) than others and higher than reports of [19] as 2.05±0.10 in milking cows fed hydroponic maize fodder. As shown in Table 2. It was revealed that the average intake of all nutrients was higher ($P<0.05$) in treatment group T_5 than other treatment groups. The average intake of crude protein was superior in T_5 than other treatments groups may be due to high palatability (which determines its consumption level) and the associative effects of other feeds and intake of T_1, T_2, T_3 and T_4 were at par with each other than lower values of T_0. The average intake of EE, CF and NFE was superior in T_5 than T_0, T_1, T_2, T_3, T_4 and T_1, T_2, T_3 and T4 treatment groups were at par with each other thanT_0. The results described above agrees with the concepts of [1] who reported supplementation improved the protein level by 68.4, 67.6, 63.0 and 58.9% over unsuplemented groups for T_2, T_3, T_4 and T_5, respectively and the CP intake of lambs increased in the order of T_5,T_4,T_3,T_2 and T_1. After the metabolic trial conducted, the average DM digestibility values of goats kept in treatment T_0 (42%) was significantly lower than insignificantly higher values of T_2 (73.30%) while average digestibility coefficient of DM in T_1, T_2, T_3, T_4 and T_5 were at par with each other (Table 2). As clearly indicated in Table 2, the DM digestibility coefficient of T_2 shows an insignificant improvement followed by T_5 and T_3 may be due to the presence of bioactive catalysts which increases digestion and absorption of nutrients and in agreement with ideas of [7] in hydroponic barley, [27] in hydroponic fodder, [14] in hydroponic barley and [17] in hydroponic barley as they denoted DM digestibility were maximum by the addition of sprouted grains in the diet of ruminants. Similar results of digestibility coefficient of DM were reported by [11] as 63.6, 57.2 and 57.5% in T_1, T_2 and T_3, respectively in growing goats fed pearl millet straw; [7] as 53.83, 55.16, 64.01, 65.83 and 64.67% in T_1, T_2, T_3, T_4 and T_5, respectively in growing Barki lambs fed barley sprout on rice straw and Tamarix and [19] pointed out DM digestibility coefficients in milking cows fed hydroponic maize fodder as 65.39±1.54%. In the present investigation, highest ($P<0.05$) digestibility coefficients (%) of CP were recorded by animals fed T_1 (91.12) followed by T_2, T_3, and T_4 with small differences to T_5 and at large difference to T_0 (68.54). The CP digestibility coefficients of T_2, T_3, and T_4 were at par with each other and significantly higher ($P<0.0$) than results of T_5 and T_0, respectively. The CP digestibility coefficients of supplemented treatment groups of T_1,T_2,T_3,T_4 and T_5 were significantly higher ($P<0.0$) than the control (T_0) groups may be due to the higher improvement in CP intake and its digestibility [13], presence of bioactive catalysts which increases digestion and absorption of nutrients [7], [27] and [24] while lowest values of control (T_0) groups may suggest that the basal diet CP was less efficiently utilized by the animals [30]. Similar results were reported by [11] as 72.2, 62.0 and 63.5% in T_1, T_2 and T_3, respectively in growing goats fed pearl millet straw; [7] as 75.04 and 70.38% in T_4 and T_5, respectively in barley sprout on rice straw and Tamarix fed to growing Barki lambs; [13] as 81.63 and 81.72% in T_1 and T_2 on sprouted maize fodder fed to desert goats respectively. The digestibility coefficient of crude fat (EE) was significantly higher in treatment T_1, T_5 and T_2 than T_3, T_0 and T_4, respectively. The results of T_1, T_5 and T_2 were at par with each other and followed by T_3, T_0, and lower values of T_4. The value of EE was insignificantly higher in goats fed maize hydroponic fodder and mixed maize and barley followed by barley hydroponic fodder may be due to high Crude fat content in maize hydroponic fodder [19]. This value was in agreement with the results reported by [13] in sprouted maize fodder fed to desert goats as T_1 (45.48%), T_2 (85.79%), T_3 (84.76%), T_4 (80.11%) and T_5 (85%) consecutively; [7] in sprouted barley grown on rice straw and Tamarix fed to growing Barki lambs and reported as 62.45, 65.21, 81.97, 83.18 and 76.02% in T_1,T_2, T_3, T_4 and T_5%, respectively and in close agreement to [19] reported as 87.69±1.35% in milking cows fed hydroponic maize fodder.

Table-2.Nutrient intake, digestibility coefficient and body weight gains of goats							
Items	**T_0**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**±SE**
Mean BW	11.03	11.01	11.01	11.01	11.01	11.03	0.26
Average DM intake(g)	317.54^{c}	425.42^{b}	425.97^{b}	415.36^{b}	404.49^{b}	504.51^{a}	16.5
Intake/ 100 kg BW(kg)	2.91^{bc}	3.10^{abc}	3.16^{ab}	2.76^{c}	2.76^{c}	3.33^{a}	0.12
Average intake of nutrients (g/day)							
DM	317.54^{c}	425.42^{b}	425.97^{b}	415.36^{b}	404.49^{b}	504.51^{a}	16.5
CP	29.85^{c}	42.85^{b}	39.12^{b}	42.18^{b}	41.14^{b}	53^{a}	1.51
EE	11.88^{c}	16.44^{b}	16.15^{b}	16.00^{b}	16.61^{b}	20.64^{a}	0.59
CF	58.63^{c}	73.89^{b}	80.63^{ab}	71.18^{b}	71.44^{b}	85.40^{a}	3.35
NFE	195.76^{c}	265.94^{b}	259.52^{b}	260.29^{b}	250.11^{b}	315.37^{a}	10.03
Digestibility coefficient (%)							
DM%	42.00^{b}	66.82^{a}	73.30^{a}	67.28^{a}	65.26^{a}	68.44^{a}	2.74
CP%	68.54^{c}	91.12^{a}	90.40^{ab}	89.67^{ab}	88.39^{ab}	87.38^{b}	1.12
EE%	73.66^{bc}	80.30^{a}	78.84^{a}	77.05^{ab}	71.84^{c}	79.02^{a}	1.61
CF%	84.30^{c}	91.6^{ab}	92.96^{a}	90.07^{b}	89.34^{b}	91.04^{ab}	0.78
NFE%	56.04^{c}	79.68^{ab}	85.29^{a}	80.84^{ab}	78.45^{b}	79.00^{b}	1.86
Nutritive value (%)							
DCP	6.09^{c}	9.83^{a}	9.53^{ab}	9.66^{a}	9.32^{b}	9.31^{b}	0.11
TDN	62.45^{c}	82.35^{ab}	85.99^{a}	82.38^{ab}	80.25^{b}	81.39^{ab}	1.53
FCE	-0.47^{d}	7.32^{c}	7.19^{c}	12.15^{a}	8.83^{c}	10.56^{ab}	0.90
Body weight gain							
B.W Gain (g/day)	-1.17^{d}	37.56^{bc}	34.74^{c}	61.93^{a}	51.44^{ab}	56.70^{a}	4.93
Final B.W (kg)	10.92^{d}	14.65^{bc}	14.38^{c}	17.02^{a}	15.99^{ab}	16.53^{a}	0.49

Means with different superscripts differ significantly ($P<0.05$).

BW: body weight, CP: crude protein, EE: ether extract, DM: dry matter, CF: crude fiber, NFE: nitrogen free extract

DCP: digestible crude protein, TDN: total digestible nutrient, FCE: feed conversion efficiency, g: gram, %: per cent, a,b,c-different superscripts differ significantly(P<0.05), T_0- control (100%) T_1- hydroponic maize fodder (20%) T_2- hydroponic barley fodder (20%) T_3- hydroponic maize fodder (40%) T_4- hydroponic barley fodder (40%) T_5- Mixed maize + barley hydroponic fodder (20%:20%).

The average CF digestibility coefficient values in the present study were observed as 84.30, 91.6, 92.96, 90.07, 89.34 and 91.04% in treatment T_0, T_1, T_2, T_3, T_4 and T_5, respectively. Statistically, the digestibility coefficient of CF in treatment T_2 was significantly higher followed by T_1 and T_5 while T_1 and T_5 were at par. T_3 and T_5 were insignificant followed by the lowest values of T_0 (84.30). Results of the present finding were significantly higher than values reported by [7] as 42.16, 48.73, 52.89, 55.93 and 52.69% in T_1, T_2, T_3, T_4 and T_5, respectively and [19] as 59.21±0.41%.

The digestibility coefficients of NFE were significantly higher in treatment T_2 followed by treatment T_1 and T_3. As clearly indicated in Table 2, the NFE values of T_4 and T_5 were insignificant followed by the lowest values of T_0. These values of present investigation were supported by [7] who found the digestibility coefficients of NFE in growing Barki lambs fed barley sprout grown in rice straw and Tamarix as 60.39, 64.95, 73.20, 76.19 and 70.30% in T_1, T_2, T_3, T_4 and T_5, respectively and [13] in sprouted maize fodder fed to desert goats and reported as 81.80, 70.39, 76.13, 75.62 and 77.91% in T_1, T_2, T_3, T_4 and T_5, respectively.

The nutritive (DCP) values of experimental diets shown in T_1 and T_3 were at par and significantly higher ($P<0.05$) than all treatment groups while, T_4 and T_5 were insignificantly ($P>0.05$) fair values followed by the lowest value of T_0 (6.09%). This result agrees with [19] as 9.65±0.49% in milking cows fed hydroponic maize fodder and comparable to close reports of [7] as 8.51% and 7.46%.The TDN value of T_2 (85.99%) was significantly higher than all other groups. There is no significant difference among T_1, T_3 and T_5 values and followed at a significant difference by T_4 and T_0, respectively. These results supported by data showed by [19] as 68.52±1.03% in milking cows fed hydroponic maize fodder and higher than [7] as 47.96, 49.67, 60.85, 63.87 and 59.25% in T_1, T_2, T_3, T_4 and T_5, respectively as well as at highest variance with findings of [13]. The progressive increment in nutritive value (DCP & TDN) may be due to the availability of grass juice factor and enzymes in hydroponic fodders that facilitates digestion [10]. The feed conversion efficiency (FCE) value of T_3 was significantly higher ($P<0.05$) than all treatment groups followed by T_5 and was at variance ($P>0.05$) with T_4, T_2, T_1, and T_0, respectively.The FCE was superior ($P<0.05$) in T_3 (maize hydroponic fodder) may be due to the highly soluble protein, amino acids and crude fat found in fresh sprouts improves digestibility [7].

The average daily body weight gain of animals in each treatment groups were -1.17, 37.56, 34.74, 61.93, 51.44 and 56.70 g/day and total body weight achieved as -0.11, 3.64, 3.37, 6.01, 4.99 and 5.50 kg of 97 days trial in T_0,T_1,T_2,T_3,T_4 and T_5, respectively. The performance in body weight gain was highly significant in T_3 (61.93 g/day) and T_5 (56.70 g/day) than other treatment groups while fair value of T_4 (51.44 g/day) was at a significant difference followed by T_1 (37.56) and T_2 (34.74) and lowest value of T_0 (-1.17g/day). The improvement in body weight gain was ranged from 34.74-61.93 g/day as compared to goats in control group that lost body weight at the rate of -1.17 g/day. The impact of supplementation was relatively more pronounced for goats supplemented with higher proportion of maize and barley hydroponic fodder could be due to the ability of the supplements to supply necessary nutrients. This was in line with the concept of [19], [31], [18] and [15] coined out hydroponic sprouts are rich source of nutrients and contain an enzyme and grass juice factors that enhances the microbial activity in the rumen and improves livestock performance and higher than reports of [6] who found no difference in cattle fed sprouted or non sprouted grain. The daily weight gain in treatment T_0 was depressed by -1.17g/day may be due to low CP content and lack of palatability with finger millet straw. This was in agreement with the reports of [11] in pearl millet straw fed for growing goats and depressed by -25.4 g/day and [1] in finger millet straw (Control) fed to lambs loss body weight by -23.3 g/day.

Therefore, it was concluded that, feeding of hydroponic maize and barley fodder up to 40% substitution (DMI) increased the digestibility of nutrients, feed conversion efficiency and body weight gain of growing goats.

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