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Nutrient composition, Mineral Profile, Digestibility, Production Performances and Economics of hydroponic Fodder Maize and Horse gram in Goats

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ABSTRACT: Inadequate availability of green fodder is commonly noticed in livestock feeding. Hydroponic fodder production is an alternative technology to increase green fodder production by vertical farming. Research works on the chemical composition, mineral profile, digestibility, production performances and economics of hydroponic fodder maize and horse gram in goats is scarce and hence a study was conducted to evaluate the nutritional characterization of hydroponic fodders and assess the potential of hydroponic fodders feeding in goats. Significantly (P<0.05) higher crude protein, Nitrogen Free Extract, Neutral Detergent Fibre, hemicellulose was observed in hydroponic fodders compared to their conventional counter parts. Phosphorus sodium, copper and selenium content were significantly (P<0.05) higher in hydroponic fodder maize compared to conventional fodder maize. The DCP (8.23 Vs 4.59; 13.93 Vs 10.12) and TDN (82.08 Vs 60.71; 70.89 Vs 58.68) per cent of hydroponic fodder maize and hydroponic fodder horse gram were significantly (P<0.05) higher than conventional fodder maize and fodder horse gram. The production performance in goats revealed that hydroponic fodder maize and hydroponic fodder horse gram in 3:1 ratio could replace conventional roughage source for growing goats. The cost of feeding per kg live weight gain of goats with hydroponic fodder maize and hydroponic fodder horse gram was much higher than feeding conventional fodder maize and fodder horse gram (146.80 Vs 457.42). Hydroponic fodders cannot be used for routine feeding but only be used as fodder during feed scarcity or calamity period.

Keywords: Hydroponic fodder maize, Hydroponic fodder horse gram, Minerals, Digestibility trial, Production performance, Economics.

INTRODUCTION

Small ruminants play a significant role in providing supplementary income and livelihood security to millions of poor farmers and landless labourers of rural India. Land and water are the primary resources for fodder production. Land allocation to cultivation of fodder crops is limited and availability of water for fodder cultivation is also limited as groundwater and freshwater resources are declining unremittingly (Rodell *et al.*, 2009). Hence, it is very much essential to evolve an alternate system for fodder production. Hydroponic fodder production system does not require land and reduce dependency on rainfall, might be an option to reduce the gap in feed supply in arid land agriculture (Fazaeli *et al*., 2017). Hydroponically growing fodder is the transformation of grains into high quality, very lush, highly nutritious, disease free grass and root combination animal feed produced in a versatile and intensive hydroponic unit (Kide, 2015). The data is scarce on the usage of hydroponic maize and horse gram fodder in goats. Keeping this in mind, study was conducted for nutritional evaluation of hydroponic fodder maize and horse gram with conventionally grown maize fodder and horse gram for studying its effect on the production performance in goats.

MATERIALS AND METHODS

The study was conducted for for nutritional evaluation of hydroponic fodder maize and horse gram with conventionally grown maize fodder and horse gram in two phases in goats 1. Growth phase 2. Lactation phase. The experiment was carried out at Sheep and Goat Unit, Post Graduate Research Institute in Animal Sciences, Tamil Nadu Veterinary and Animal Sciences University following the standard ethical guidelines.

A. Chemical composition of hydroponic fodder with growth period

Samples (200 g) of hydroponic fodder maize were collected on 7th, 8th, 9th and 10th day and horse gram were collected on 5th, 6th, 7th and 8th day evaluated for their moisture (AOAC, 2012). The proximate compositions of the dried samples were determined according to standard methods of AOAC (2012). The loss / gain of proximate principles for both hydroponic fodder maize and hydroponic fodder horse gram from their original seeds was also calculated and presented on % DMB.

B. Fibre fractions of hydroponic fodder maize and horse gram

The leaf samples were analyzed for neutral detergent fibre (NDF), acid detergent fibre (ADF), lignin and cellulose according to Van Soest *et al.* (1991). Percentage hemicellulose content was obtained by finding the difference between NDF and ADF values (Church, 1975).

C. Mineral composition of hydroponic fodder maize and horse gram

Mineral analysis were carried out by ICP-OES (Szymczycha *et al.*, 2013). Phosphorus was determined calorimetrically using Ammonium Vanadate (AOAC, 1980).

D. Digestibility trial in goats

A digestibility trial by difference method was carried out to determine the nutrient digestibility of hydroponically grown fodder maize and hydroponically grown fodder horse gram as against the digestibility of conventionally grown fodder maize and conventionally grown fodder horse gram. Eight adult male non descript goats of 18 months age, having a mean body weight 15 kg were selected for the experiment. The goats were randomly distributed into two treatments (T_1 and T_2) in such a manner that each treatment group had 4 animals. The animals were housed individually in metabolism crates. All the animals were dewormed and dipped prior to the start of the experiment.

Composite samples of feed offered, leftover and feces were thawed to room temperature, mixed thoroughly and estimated for their moisture (AOAC, 2012). Samples were analysed for crude protein, crude fibre, ether extract, total ash and nitrogen free extractives (AOAC, 2012). The digestibility coefficient of conventional or hydroponic maize and horse gram was calculated as a difference between nutrient intake and nutrient voided in the feces divided by nutrient intake and the quotient multiplied by 100.

E. Production performance in goats

A growth trial was carried out in kids to ascertain the impact of feeding hydroponically grown fodder maize and fodder horse gram as against feeding of conventionally grown fodder maize and fodder horse gram on growth parameters. The experiment was carried out at Sheep and Goat Unit, Post Graduate Research Institute in Animal Sciences, Tamil Nadu Veterinary and Animal Sciences University.

Twelve Boer cross bred, weaned kids, 3 months of age, having a mean body weight 8.6 kg were selected for the experiment. There were eight female and four male kids among the selected kids. The kids were randomly distributed into two treatments (T_1 and T_2) in such a manner that each treatment group had 6 animals (two male and four female) and the mean body weight of kids in both the groups showed no significant variation. The kids were housed as a group in two pens, one each for each treatment group. Floor space, feeder space and watering space was provided as per standard specification. All the animals were dewormed and dipped prior to the start of the experiment.

The experiment was for a period of 60 days. Experimental rations were formulated with 60 per cent roughage (75 % non legume and 25 % legume) to 40 per cent concentrate, to meet out the DCP requirement of 37 g /day and TDN requirement of 355 g/day (Ranjhan, 1998). The kids in T_1 were offered conventionally grown fodder maize and fodder horse gram as roughage whereas the kids in T_2 were offered hydroponically grown fodder maize and fodder horse gram as roughage. The ingredient composition of experimental rations provided is presented in Table 1. The ingredient composition of the concentrate mixture varied between treatments and the same is presented in Table 2.

Table 1: Ingredient composition of experimental ration offered to kids.

Sr. No.	Ingredients	Inclusion level (% ration)	
		Treatment 1	**Treatment 2**
	Roughage	60.00	60.00
1.	Conventional fodder maize	45.00	-
2.	Conventional fodder horse gram	15.00	-
3.	Hydroponic fodder maize	-	45.00
4.	Hydroponic fodder horse gram	-	15.00
	Concentrate mixture	40.00	40.00
	Nutritive value (Calculated)		
	DCP (%)	8.38	8.99
	TDN (%)	74.35	76.36

Table 2: Ingredient composition of concentrate mixture included in experimental ration offered to kids.

Sr. No.	Ingredients	Inclusion level (% ration)	
		Treatment 1	Treatment 2
1.	Maize	35.00	50.00
2.	Wheat bran	24.00	-
3.	Deoiled rice bran	26.00	23.50
4.	Soyabean meal	12.00	-
5.	Gram screenings	-	23.50
6.	Salt	1.0	1.00
7.	Mineral mixture	2.00	2.00
	Nutritive value (Calculated)		
	DCP (%)	12.34	7.79
	TDN (%)	74.30	70.55

The parameters that were studied during this experiment included changes in body weight of kids, feed intake, feed conversion ratio, livability and body condition score. Serum glucose, total protein, triglyceride, cholesterol, calcium and phosphorus were also analyzed during the study.

All kids in both the treatments at the beginning and at the end of the experiment were subjected to body condition score as per Villaquiran *et al*. (2004). A panel of six experts conducted the body condition score at the beginning and at the end of the experiment.

At the start of the feeding trial and at the end of 60 days of feeding trial, blood samples were collected using vacutainers from the jugular vein of all the animals in the trial and were centrifuged at 1400 g for 10 minutes to separate serum. The serum was transferred into vials, labeled and stored at -20 ºC until used. Serum samples were analyzed for total protein by GOD-PAP method, serum albumin by BCG method, total cholesterol by CHOD-PAP method, serum triglyceride (TG) by GPO-TOPS, calcium by Arsenazo III method and glucose by GOD-PAP method using auto analyser A15 Biosystem.

F. Statistical analysis

Data collected were analyzed using analysis of variance (ANOVA) using IBM SPSS statistics 20.

RESULTS AND DISCUSSION

A. Changes in chemical composition of hydroponic fodder with growth period

The proximate composition (% DMB) of maize grain before sprouting and at different days of growth after sprouting is presented in Table 3.

Table 3: Proximate composition (% DMB) of maize grain before sprouting and hydroponic fodder maize at different days of growth (Mean* ± SE).

Proximate composition (% DMB)	Maize grain before sprouting	Hydroponic fodder maize - Days of harvest			
		7th day	8th day	9th day	10th day
Dry matter	$93.17^{e} \pm 0.10$	$22.80^{d} \pm 0.07$	$22.23^{c} \pm 0.24$	$21.45^{b} \pm 0.31$	$20.82^{a} \pm 0.06$
Crude protein	$8.57^{a} \pm 0.16$	$11.24^{b} \pm 0.27$	$12.09^{c} \pm 0.03$	$11.69^{bc} \pm 0.54$	$11.73^{bc} \pm 0.07$
Crude fibre	$3.30^{a} \pm 0.27$	$9.28^{b} \pm 0.35$	$10.20^{b} \pm 0.37$	$10.39^{bc} \pm 0.19$	$10.86^{c} \pm 0.09$
Ether extract	$3.59^{ab} \pm 0.28$	$3.31^{a} \pm 0.00$	$3.54^{ab} \pm 0.26$	$3.65^{ab} \pm 0.19$	$3.78^{ab} \pm 0.04$
Total ash	$1.17^{a} \pm 0.32$	$2.03^{b} \pm 0.01$	$2.23^{b} \pm 0.09$	$2.89^{c} \pm 0.02$	$2.94^{c} \pm 0.01$
Nitrogen free extract	$83.37^{d} \pm 0.47$	$74.14^{c} \pm 0.75$	$71.94^{b} \pm 0.15$	$71.38^{b} \pm 0.91$	$70.69^{a} \pm 0.12$

*Mean of six replications

a, b, c, d, e Means bearing different superscripts within row differ significantly (P<0.05)

In hydroponic fodder maize, significant (P<0.05) decline in dry matter (DM) and nitrogen free extract (NFE) was evident with increase in days of harvest, with lowest values on 10th day of harvest. However, the hydroponic maize fodder had significantly (P<0.05) higher crude protein compared to maize seeds in all days of harvest. Significantly (P<0.05) highest crude protein was observed at 8th day of harvest. The increase was to the tune of 3.52 per cent.

The proximate composition (% DMB) of horse gram seeds before sprouting and at different days of growth after sprouting is presented in Table 4.

Table 4: Proximate composition (% DMB) of horse gram grain before sprouting and hydroponic fodder horse gram at different days of growth (Mean* ± SE).

Chemical composition	Horse gram grain before sprouting	Hydroponic fodder horse gram - Days of harvest			
		5th day	6th day	7th day	8th day
Dry matter	$93.77^{c} \pm 0.09$	$14.18^{a} \pm 0.18$	$15.35^{b} \pm 0.53$	$15.73^{b} \pm 1.16$	$16.40^{b} \pm 0.05$
Crude protein	$10.43^{a} \pm 0.21$	$17.45^{b} \pm 0.17$	$17.27^{b} \pm 0.29$	$17.58^{b} \pm 0.18$	$17.60^{b} \pm 0.10$
Crude fibre	$2.73^{a} \pm 0.04$	$12.59^{bc} \pm 0.17$	$12.32^{b} \pm 0.74$	$12.60^{bc} \pm 0.19$	$13.18^{c} \pm 0.05$
Ether extract	$2.13^{a} \pm 0.17$	$2.98^{ab} \pm 0.24$	$2.94^{ab} \pm 0.94$	$3.26^{b} \pm 0.70$	$3.98^{b} \pm 0.01$
Total ash	$3.64^{a} \pm 0.11$	$5.12^{bc} \pm 0.18$	$5.00^{bc} \pm 0.47$	$4.80^{b} \pm 0.01$	$5.26^{c} \pm 0.17$
Nitrogen free extract	$81.05^{c} \pm 0.02$	$61.85^{ab} \pm 0.39$	$61.59^{ab} \pm 1.77$	$62.03^{b} \pm 0.64$	$60.54^{a} \pm 0.27$

*Mean of six replications

a,b,c,d Means bearing different superscripts within row differ significantly (P<0.05)

In hydroponic fodder horse gram, significant (P<0.05) decline in dry matter (DM) and nitrogen free extract (NFE) was evident with increase in days of harvest, with lowest values on 8th day of harvest. Hydroponic fodder horse gram had significantly (P<0.05) higher crude protein compared to horse gram seeds in all days of harvest. The increase in crude protein was to the tune of 6.84 to 7.17 per cent.

Naik *et al.* (2012) evaluated the nutrient changes during growth of hydroponic fodder maize. The crude protein had increasing trend and remained highest on 7th day of growth (13.57 per cent). Farghlay *et al*. (2019) also reported reduction in dry matter and rise in crude protein in hydroponic fodders compared to the grains.

The comparison of proximate composition and acid insoluble ash (% DMB) of hydroponic fodder maize and hydroponic fodder horse gram with conventional fodder maize and horse gram is presented in Table 5.

Table 5: Comparison of proximate composition and acid insoluble ash (% DMB) of hydroponic fodder maize and hydroponic fodder horse gram with conventional fodder maize and conventional fodder horse gram (Mean* ± SE).

Parameters	Fodder maize		Fodder horse gram	
	Conventional fodder	Hydroponic fodder	Conventional fodder	Hydroponic fodder
Dry matter	24.83^{b} ± 0.78	20.06^{a} ± 0.11	23.53^{b} ± 0.09	21.83^{a} ± 0.00
Crude protein	8.48^{a} ± 0.00	11.78^{b} ± 0.27	16.04^{b} ± 0.78	17.65^{b} ± 0.14
Crude fibre	25.95^{b} ± 1.21	10.57^{a} ± 0.37	31.88^{b} ± 2.19	14.58^{a} ± 0.00
Ether extract	2.35^{a} ± 0.01	3.27^{b} ± 0.04	3.08^{b} ± 0.00	2.56^{a} ± 0.01
Total ash	5.49^{b} ± 0.35	2.02^{a} ± 0.01	6.89^{b} ± 0.88	4.86^{a} ± 0.08
NFE	57.73^{a} ± 0.85	72.36^{b} ± 0.15	42.11^{a} ± 0.53	60.35^{b} ± 0.23
AIA	1.24 ± 0.13	0.42 ± 0.00	1.01± 0.09	0.97 ± 0.06

* Mean of six replications

a,b Means bearing different superscripts within row for respective fodder differ significantly (P<0.05)

Conventionally grown fodder maize had significantly (P<0.05) higher dry matter, crude fibre, total ash and acid insoluble as compared to hydroponically grown fodder maize. However, it had significantly (P<0.05) lower crude protein, ether extract and nitrogen free extract as compared to hydroponically grown fodder maize. Higher crude fibre values in conventional maize fodder was also reported by Azim *et al*. (1989); Naik *et al*. (2012).

Similarly, conventionally grown horse gram had significantly (P<0.05) higher dry matter, crude fibre, total ash and acid insoluble as compared to hydroponically grown horse gram. Whereas, hydroponically grown horse gram had significantly (P<0.05) higher crude protein, ether extract and nitrogen free extract as compared to conventionally grown horse gram. The crude protein of hydroponic horse gram reported in this study was lower whereas the NFE content was higher. The crude fibre, ether extract and total ash values were comparable to that reported by Jemimah *et al*. (2017).

Sprouting alters the amino acid profile of seeds and increases the crude protein content of hydroponic fodder (El-Morsy *et al*., 2013). The absorption of nitrates facilitates the metabolism of nitrogenous compounds from carbohydrate reserves, thus increasing crude protein levels (Morgan *et al.,* 1992). The crude protein level of conventional fodder was reduced significantly (P<0.05) due to plant maturity (Azim *et al*., 1989). The crude fibre content of conventional fodder was higher than hydroponic fodder due to the buildup of cellulose, varied proportions of hemicelluloses and lignin (Cuddeford, 1989). Maturity impresses the crude fibre content of green fodder. The matured stem portion of conventional fodder contained more crude fiber than soft portion (stem and leaves) of the hydroponic fodder (Kide, 2015). The increase in ether extract content of hydroponic fodder is attributed to the increase in the structural lipids and production of chlorophyll associated with the plant growth (Naik *et al.,* 2015). Sri Widiastuti *et al.* (2022) reported similar levels of crude protein (11.35 %), total ash (2.34 %) and higher levels of crude fat (4.95 %) and crude fibre content (15.21 %) in hydroponic maize fodder.

B. Fibre fractions of hydroponic fodder maize and horse gram

The comparison of fibre fractions (% DMB) of hydroponic fodder maize and hydroponic fodder horse gram with conventional fodder maize and horse gram is presented in Table 6.

Table 6: Comparison of fibre fractions (% DMB) of hydroponic fodder maize and hydroponic fodder horse gram with conventional fodder maize and conventional fodder horse gram (Mean* ± SE).

Fibre fractions (%)	Fodder maize		Fodder horse gram	
	Conventional fodder	Hydroponic fodder	Conventional fodder	Hydroponic fodder
Neutral detergent fibre	62.04^{a} ± 1.44	73.70^{b} ± 1.21	49.67^{a} ± 0.08	74.55^{b} ± 3.82
Acid detergent fibre	53.94^{b} ± 7.19	24.33^{a} ± 6.09	38.81^{a} ± 2.03	53.41^{b} ± 0.92
Cellulose	27.82^{b} ± 4.47	8.57^{a} ± 1.10	14.64^{b} ± 1.92	8.69^{a} ± 0.01
Hemicellulose	13.54^{a} ± 1.74	45.16^{b} ± 1.88	10.85^{a} ± 1.95	21.14^{b} ± 4.75
Lignin	5.29^{b} ± 1.18	1.62^{a} ± 0.43	4.07^{b} ± 0.37	1.22^{a} ± 0.02

* Mean of six replications

a,b Means bearing different superscripts within row for respective fodder differ significantly (P<0.05)

Conventional fodder maize had significantly (P<0.05) higher ADF, cellulose and lignin as compared to hydroponically grown fodder maize. However, NDF and hemicellulose was significantly (P<0.05) higher in hydroponically grown fodder maize.

Hydroponically grown horse gram had significantly (P<0.05) higher NDF, ADF and hemicellulose as compared to conventionally grown horse gram. However, cellulose and lignin was significantly (P<0.05) higher in conventionally grown horse gram as compared to hydroponically grown horse gram.

However, Khanna (2015) reported lower values for all fibre fractions in hydroponic fodder maize as compared to what was observed in the present study. Karaki (2011); Fazaeli (2012); Helal (2015); Rahim *et al.* (2015); Mysaa Ata (2016) also had reported lower NDF and ADF values in hydroponic barley as compared to values reported in this study. Chethan *et al.* (2022) reported lower levels of NDF - 33%, ADF - 15.5%, hemi cellulose - 17.5 %, lignin - 0.98 % and higher level of cellulose - 13.2 % in hydroponic maize grain sprouts.

C. Mineral composition of hydroponic fodder maize and horse gram

The mineral composition of hydroponic fodder maize and hydroponic fodder horse gram with conventional fodder maize and horse gram is presented in Table 7.

Table 7: Comparison of mineral content of hydroponic fodder maize and hydroponic fodder horse gram with conventional fodder maize and conventional fodder horse gram (Mean* ± SE).

Mineral content	Fodder maize		Fodder horse gram	
	Conventional fodder	Hydroponic fodder	Conventional fodder	Hydroponic fodder
Calcium (%)	0.07 ± 0.00	0.06 ± 0.00	0.29^{b} ± 0.01	0.07^{a} ± 0.00
Phosphorous (%)	0.16^{a} ± 0.00	2.10^{b} ± 0.11	1.48^{NS} ± 0.01	2.01^{NS} ± 0.32
Sodium (%)	0.27^{a} ± 0.05	1.35^{b} ± 0.04	1.62^{b} ± 0.01	0.72^{a} ± 0.13
Potassium (%)	0.14^{b} ± 0.00	0.03^{a} ± 0.00	0.06^{NS} ± 0.00	0.08^{NS} ± 0.01
Zinc (ppm)	61.35^{NS} ± 6.16	85.55^{NS} ± 28.13	80.00^{NS} ± 21.36	90.15^{NS} ± 9.47
Copper (ppm)	8.80^{a} ± 1.50	36.95^{b} ± 0.28	15.70^{NS} ± 0.50	12.25^{NS} ± 6.16
Selenium (ppm)	359.00^{a} ± 245.93	752.40^{b} ± 0.60	673.40^{NS} ± 51.15	751.60^{NS} ± 21.66
Iron (ppm)	782.10^{b} ± 58.57	164.85^{a} ± 13.28	1123.00^{b} ± 146.43	301.93^{a} ± 214.13
Cobalt (ppm)	7.40^{a} ± 0.00	11.05^{b} ± 0.25	12.85^{NS} ± 0.05	13.80^{NS} ± 1.70

* Mean of six replications

a,b Means bearing different superscripts within row for respective fodder differ significantly (P<0.05) NS - Not statistically significant

Sri Widiastuti *et al.* (2022) reported higher levels of calcium (0.44 %) and phosphorus (0.77 %) and lower level of sodium content (0.014%) in hydroponic maize fodder.

D. Digestibility trial in adult goats

The nutrient digestibility of conventional Vs hydroponic fodder maize and fodder horse gram is presented in Table 8.

Table 8: Nutrient digestibility of conventional Vs hydroponic fodder maize and hydroponic fodder horse gram.

Nutrient Digestibility (% DMB)		Fodder Maize		Fodder Horse gram	
		Conventional	Hydroponic	Conventional	Hydroponic
Digestibility Coefficient	Dry matter	69.53^{NS} ± 3.99	70.19^{NS} ± 8.10	55.15^{a} ± 0.53	65.38^{b} ± 1.39
	Crude protein	54.15^{a} ± 8.99	69.88^{b} ± 6.33	63.11^{a} ± 9.40	78.94^{b} ± 0.52
	Crude fibre	57.09^{a} ± 3.38	78.08^{b} ± 9.96	65.24^{NS} ± 10.01	69.59^{NS} ± 1.61
	Ether Extract	68.10^{NS} ± 3.60	68.16^{NS} ± 10.17	70.44^{NS} ± 0.52	73.14^{NS} ± 4.10
	NFE	65.31^{a} ± 3.67	83.71^{b} ± 2.54	54.21^{a} ± 7.39	70.60^{b} ± 1.85
DCP		4.59^{a} ± 0.75	8.23^{b} ± 0.74	10.12^{a} ± 1.50	13.93^{b} ± 0.09
TDN		60.71^{a} ± 3.57	82.08^{b} ± 3.94	58.68^{a} ± 5.16	70.89^{b} ± 1.18

* Mean of six replications

a,b Means bearing different superscripts between columns for respective fodders differ significantly (P<0.05)

NS - Non significant

No significant variation (P>0.05) existed in the digestibility coefficient of dry matter and ether extract between conventional and hydroponic fodder maize. However, digestibility coefficient of crude protein, crude fibre and NFE was significantly (P<0.05) higher in hydroponic fodder maize compared to conventional fodder maize.

No significant variation (P>0.05) existed in the digestibility coefficient of crude fibre and ether extract between conventional and hydroponic fodder horse

gram. However, digestibility coefficient of dry matter, crude protein, and NFE was significantly (P<0.05) higher in hydroponic fodder horse gram compared to conventional fodder horse gram.

Naik *et al.* (2014) also had reported that feeding of hydroponic fodder increased the digestibility of the nutrients. The increased digestibility of the nutrients of the ration could be attributed to the tenderness of the fodder. Chethan *et al.* (2022) reported better digestibility at higher inclusion level of maize grain sprouts in the diet of lambs.

E. Production performance in goats

The results of the experiment carried out to determine whether the hydroponic fodder maize and hydroponic fodder horse gram could support the production performance of goats as compared to their conventional counterparts.

To ascertain the impact of feeding hydroponically grown fodder maize and horse gram as against feeding of conventionally grown fodder maize and fodder horse gram on growth parameters a growth trial was carried out in Boer cross bred kids, the results of which is presented in this section. The growth parameters of kids as influenced by feeding conventional fodder maize and fodder horse gram Vs hydroponic fodder maize and hydroponic fodder horse gram is presented in Table 9.

No significant (P>0.05) variation was observed in initial body weight, final body weight, gain in body weight, average daily gain, initial body condition score, final body condition score, total dry matter intake, feed conversion ratio and livability between treatment groups. However, the average daily gain in treatment 1 animals fed conventional fodder maize and horse gram was 18.2 g higher than animals in treatment 2 which were fed hydroponic fodder maize and horse gram. The dry matter intake in treatment 1 animals fed conventional fodder maize and horse gram was 0.09 kg higher than animals in treatment 2 which was fed hydroponic fodder maize and horse gram. The dry matter intake as per cent body weight was 4.63 Vs 4.40 for animals fed conventional Vs hydroponic fodder maize and horse gram.

Table 9: Growth parameters (Mean*± SE) of kids as influenced by feeding conventional fodder maize and fodder horse gram Vs hydroponic fodder maize and hydroponic fodder horse gram.

Sr. No.	Parameters	Conventional fodder maize and horse gram - T_1	Hydroponic fodder maize and horse gram - T_2
1.	Initial body weight - 3rd month (kg) ^{NS}	8.77 ± 0.47	8.67 ± 0.70
2.	Final body weight - 6th month (kg) ^{NS}	11.96 ± 0.81	10.77 ± 0.87
3.	Gain in body weight (kg) ^{NS} (60 days)	3.19 ± 0.46	2.10 ± 0.33
6.	Average Daily Gain (g) ^{NS}	53.2 ± 7.56	35.00 ± 5.63
4.	Initial body condition score ^{NS}	2.5 - 3.5	2.5 - 3.5
5.	Final body condition score ^{NS}	2 .5 - 3.5	2.5 - 3.5
8.	Dry matter intake % body weight ^{NS}	4.63	4.40
9.	Dry matter intake / kg W $^{0.75\ NS}$	3.15	3.04
10.	Feed conversion ratio ^{NS}	10.15	12.85
11.	Livability (%) ^{NS}	100	100

*Mean of six replications; NS - Non-Significant

Compared to the average daily gain documented in this study Jemimah *et al.* (2017) reported higher weight gain in Tellicherry kids fed hydroponic horse gram/sun hemp replacing 50 per cent of concentrate mixture. Augilar *et al.* (2009) also reported that in goat diets that included hydroponic green fodder at 70 and 25 per cent, it significantly (P<0.05) increased goat weight gain, at 134.7 and 144.3 g/day respectively. Kide (2015) reported that the impact of supplementation on weight gain was relatively more pronounced for Konkan Kanyal goats supplemented with higher proportion of maize and barley hydroponic fodder.

The recommended dry matter intake for meat type goats is 3.5 to 4.0 percent of their body weight (ICAR, 2015). In the present study dry matter intake as percent body weight of 4.40 was observed for goats fed hydroponic fodder maize and hydroponic fodder horse gram, which indicates that these fodders offered in combination are palatable. However, the dry matter intake of hydroponic fodders though statistically in significant (P>0.05), was lower as compared to conventional fodder (4.63). Hydroponic fodder is palatable and the germinated seeds embedded in the root system are also consumed along with the shoots of the plants without any nutrient wasting (Pandey and Pathak, 1991). Sometimes, animals take the leafy parts of the hydroponic fodder and the root portions are not consumed which can be avoided by mixing the hydroponic fodder with the other roughage components of the ration (Naik *et al.*, 2014).

However, in spite of the better bioavailability of nutrients, the average daily gain of animals fed hydroponic fodder was only comparable to average daily gain observed for animals fed conventional fodder, a significantly (P<0.05) positive response in growth rate was not documented, probably due to a slightly lower dry matter intake (0.23 per cent) in animals fed hydroponic fodder as compared to animals fed conventional fodder maize and conventional fodder horse gram.

Serum biochemical parameters were not influenced by the feeding of hydroponic fodders, indicating once again the nutritional adequacy of the fodders offered to the goats. Hematology and serum biochemistry assay of livestock determine the physiological disposition of the

animals to their nutrition (Onasanya *et al*., 2015). The serum protein and lipid concentrations are affected by diet / nutrition (Swanson *et al*., 2004).

The serum glucose, total protein, triglyceride, cholesterol, calcium and phosphorus of kids as influenced by feeding conventional fodder maize and fodder horse gram Vs hydroponic fodder maize and fodder horse gram is presented in Table 10.

Table 10: Serum glucose, total protein, triglyceride, cholesterol, calcium and phosphorus of kids as influenced by feeding conventional fodder maize and horse gram Vs hydroponic fodder maize and horse gram (Mean*± SE).

Sr. No.	Parameters (mg/dl)	Conventional fodder maize and horse gram - T_1 NS	Hydroponic fodder maize and horse gram - T_2 NS
1.	Glucose	36.66 ± 7.45	76.83 ± 2.87
2.	Total protein	5.56 ± 0.23	5.13 ± 0.11
3.	Albumin	3.08 ± 0.07	3.18 ± 0.04
4.	Triglycerides	36.86 ± 6.15	33.33 ± 4.44
5.	Cholesterol	43.41± 7.58	47.16 ± 8.15
6.	Calcium	10.04 ± 0.91	10.76 ± 0.55
7.	Phosphorus	9.26 ± 0.62	11.37 ± 0.75

*Mean of six replications; NS - Non-Significant

No significant (P>0.05) variation was observed in serum glucose, total protein, triglyceride, cholesterol, calcium and phosphorus of kids as influenced by feeding conventional fodder maize and horse gram Vs hydroponic fodder maize and horse gram. Arif *et al.* (2023) observed non-significant variation (P>0.05) for blood metabolites in weaned beetal goat kids fed with hydroponic fodder maize and barley.

Verma *et al.* (2015) studied effect of feeding hydroponic barley (*Hordeum vulgare* L.) fodder on blood metabolites in Hariana male calves and observed that the values of blood parameter were similar in all three groups namely T_1 (Control), T_2 (0.55 kg concentrate mixture and 2.5 kg hydroponic barley fodder) and T_3 (5 kg hydroponic barley fodder) groups.

The rural physiological range of estimated serum mineral contents had no adverse effects to growing lambs on inclusion of maize grain sprouts to substitute conventional green fodder or concentrate feed (Chethan *et al.*, 2022).

The economics of feeding conventional fodder maize and horse gram Vs hydroponic fodder maize and horse gram to kids is presented in Table 11.

Table 11: Economics of feeding conventional Vs hydroponic fodder maize and fodder horse gram to kids.

Sr. No.	Parameters	Conventional fodder maize and conventional fodder horse gram - T_1	Hydroponic fodder maize and hydroponic fodder horse gram - T_2
1.	Intake Fodder maize (FMB kg / day)	0.800	0.960
2.	Intake Fodder horse gram (FMB kg / day)	0.300	0.252
3.	Intake concentrate (FMB kg / day)	0.218	0.218
4.	Total fresh matter intake (kg)	1.318	1.43
5.	Cost of feed and fodder (INR / kg) Maize Horse gram Concentrate	 3.00 3.50 20.00	 6.06 9.72 18.50
6.	Cost (INR) for intake of Fodder maize per animal per day	2.40	5.82
7.	Cost (INR) for intake of Fodder horse gram per animal per day	1.05	2.45
8.	Cost (INR) for intake of concentrate per animal per day	4.36	4.03
9.	Total feed cost (INR) per animal per day	7.81	12.30
10.	Average Daily Gain (g) NS	53.2	35.00
11.	Feed cost (`INR) per kg live weight gain	146.80	351.42

From the Table 11, it is obvious that the feed cost (INR) per kg live weight gain of animals fed with hydroponic fodder maize and hydroponic fodder horse gram was much higher (68 per cent) than in animals that are fed with conventional fodder maize and conventional fodder horse gram.

Fazaeli *et al.* (2011) also reported that from economical point of view, feed cost increased up to 24 per cent when the calves were offered hydroponic barley, because of the costly production of hydroponic green forage.

The cost of the hydroponic fodder is mainly influenced by the seed cost as it contributes about 90 per cent of the total cost of production (Naik *et al*., 2012). Chethan *et al.* (2022) reported that replacement of compounded feed mixture or conventional green fodder with maize grain sprout will limit the dry matter intake, net nutrient availability and negatively affect the growth

performance in lambs and also not economical in terms of feeding cost.

Owing to the high cost involved in the production of hydroponic fodder it is not remunerative to feed it to livestock as a routine basis. Option of using hydroponic fodder for feeding livestock is warranted only when it becomes highly essential, especially in situations of extreme drought, natural calamities when production of fodder in soil becomes impossible, in highly arid regions of the state and the country.

Lactation studies in does. The body weight changes, milk yield, fat and SNF content of does as influenced by feeding conventional fodder maize and horse gram Vs hydroponic fodder maize and horse gram is presented in Table 12.

Table 12: Body weight changes, milk yield, fat and SNF content (Mean* ± SE) of does as influenced by feeding conventional Vs hydroponic fodder maize and horse gram.

Sr. No.	Parameters	Conventional fodder maize and conventional fodder horse gram - T_1	Hydroponic fodder maize and hydroponic fodder horse gram - T_2
1.	Initial body weight (kg)	31.20 ± 1.20	30.90 ± 2.50
2.	Final body weight (kg)	32.00 ± 1.00	31.30 ± 1.20
3.	Loss / Gain in body weight (kg)	0.800 ± 0.020	0.400 ± 0.010
4.	Milk yield (ml/day)	320 ± 25.10	300 ± 20.70
5.	Milk Fat (%)	3.20 ± 0.02	3.25 ± 0.04
6.	Milk SNF (%)	8.50 ± 0.50	8.40 ± 0.50

*Mean of six replications; NS - Non-Significant

No significant variation (P>0.05) was observed in body weight changes, milk yield, fat and SNF content of does as influenced by feeding conventional fodder maize and horse gram Vs hydroponic fodder maize and horse gram.

Contradictory to the results of this study Micera *et al.* (2009) reported that integration with hydroponically germinating oat in partial substitution of the complete feed for sheep seems to produce an improvement in production of milk.

CONCLUSIONS

The nutritive value of hydroponic fodders *viz.* fodder maize and fodder horse gram is higher compared to their conventional counterparts as reflected by their higher crude protein. Hydroponic fodder maize and hydroponic fodder horse gram in the ratio of 3: 1 can replace conventional roughage source for growing goats without adversely affecting DMI, body condition, growth rate and Feed Conversion Ratio.

The cost of feeding per kg live weight gain of goats with hydroponic fodder maize and hydroponic fodder horse gram is much higher than feeding conventional fodder maize and conventional fodder horse gram (INR 351.42 Vs INR 146.80), suggesting that hydroponic fodders cannot be used routinely but only be used as fodder during feed scarcity or calamity period.

FUTURE SCOPE

Feeding studies in goats with other hydroponic fodders can be studied for feeding during feed scarcity or calamity period**.**

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Conflicts of Interest. None.

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