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Effect of substituting natural pasture hay with mixture of cowpea and sthylosanthes humilis as basal diet on body weight gain and carcass characteristics of gumuz goat

Bainesagn Wolelie[1*], Mezgebu Alebel[2]
[1, 2] Ethiopian Institite of Agricultural Research, Debre Markos, Agricultural Research Center, Debre Markos, Ethiopia

Abstract
The study was designed to evaluate the effects of replacing natural pasture hay with different proportions of Sthylosanthes humilis and Vigna unguiculata (cowpea) hay on growth performance and carcass characteristics of Gumuz Goat. About 169g of maize, toasted soyabean and 5% (roughage ration) molasses per day were given for all treatments throughout the experimental period. Thirty yearling Gumuz male goats with an average initial body weight of 17.22 ± 2.85 kg (mean ± SEM) were used in randomized complete block design (RCBD) that lasted for 90 days. Treatments were arraged to replace 50% of natural pasture hay with different proportions of cowpea and sthylosanthes humilis. Treatments were sole natural pasture hay as controled treatment (T1), 80% and 20% (T2), 70% and 30% (T3), 50% and 50% (T4) and 25% and 75% mixture of sthylosanthes humilis and cow pea substituting natural pasture hay respectively. Goats were grouped into six blocks of which five goats in each based on their initial body weight. The study result showed that higher (P<0.05) final body weight, average daily gain and hot carcas weight of Gumuz goat were observed on treatment groups consumed substitute roughage than goats fed sole natural pasture hay as basal diet. Similarly, dressing percentage based on slaughter body weight base was higher (P>0.05) than sole natural pasture hay. Hot carcass weight ranged from 7.86 kg to 11.62 kg through the substitution of sthylosanthes and cow pea at diffrent proportions. The result showed that the substitute was better to improve the growth and carcass parameter of Gumuz goat. Therefore sthylosanthes humilis and cow pea substitution at ratio of 50:50 was recommended as best natural pasture hay replace for basal diet and similarly 70 to 30 sthylosantus to cow pea ratio could be used as alternative to improve the performance and carcas yield in gumuz goat.

Keywords: dressing percentage, edible offals, hot carcass weight, non-edible offals, slaughter weight

1. Introduction
Ethiopia is home for large number of diversified goat population in Africa. According to [1], there are about 32.74 million goat population, making the country second in Africa. Benishangul Gumz Region constitutes large livestock resources of cattle, sheep, goat, mule, donkey, poultry and bee hive, 558551, 93131, 411503, 2532, 53222, 1305785, and 254664, respectively [2].

According to [3]. the value of foreign exchange earnings derived from goats is lower than would be expected due to many technical and non-technical constraints. From the other end, domestic and export demand for goat meat seem to be increasing mainly due to urbanization, presence of big investment areas around (Belles Integrated Sugar Development Project, Great Renaissance Dam), growth in per capita income and human population.

The major factors affecting the productivity of goats in sub-Sahara African countries including Ethiopia have been identified to be poor nutrition, genotype, animal management, policy and institutional constraints. Lack of quality feed especially during the dry season is a key problem for the low productivity of animals [4]. About 90% of the feedstaffs used for animals in Ethiopia are from natural pasture which are characterized by their low nutrient contents particularly protein [5]. In metekel zone Natural pasture is the main source of livestock feed, which is severely in short supply during dry season as well as poor in quality. The contributing factors for feed quality Deterioration in the area include: encroachment pasture lands by invasive weeds, uncontrolled fire Shortage of animal feed during the dry season lasts from January to May during which period animals also suffer from poor quality basal feed resources.

Provision of appropriate and complementary supplementary feedstuffs would be the best alternative strategies to alleviate nutritional problems and enhance the productivity of goat under smallholder farmers in Ethiopia. In order to mitigate the problems associated with low quality protein mixture of natural pasture supplements due to reasons lignification natural pasture and encroachment of invasive allian weeds, there is a need to look for alternative protein sources integration the natural pasture such as supplementation with forage legumes that farmers can produce at their own farms. Supplementation of low-quality feed with legumes increased voluntary intake [6]. and improved animal performance interms of daily weight gain [7, 8, 9, 10].

Reported 41% increase in daily weight gain of goats fed intercrop of guinea and sthylosanthes hamata as compared with goats fed on guinea grass alone. Pawe agricultural research had so far made a lot of efforts on improved legume forages. Among the forages, cowpea (Vigna Unguiculata) which registered legume forage variety [11]. and Stylosantus Humilis could be easily grown at farmers' levels and play an important role in supplementing diets of growing goats as alternative to concentrate mixture

Supplements. Therefore, the objective of this paper was

- To evaluate the response of different proportions of cowpea & stylosantus himiulis as basal diet substitute supplement
- To generate information about the feeding efficiency of these legume forages for goat

2. Materials and Method

2.1 Description of study area

The experimental trial was conducted at pawe research center, which is located at 572 km from the capital city of Ethiopia at an altitude of 1100 m above sea level in North West of Ethiopia. The agro ecological zone of the area is semi-arid and sub humid with mixed crop- livestock production system with little agro pastural. Its geographical location lies within the co-ordinates of 11°12' -11°21' north latitude and 36°20'- 36°21' east longitudes. The mean annual minimum and maximum Temperatures are, 16.3°C and 32.6°C respectively. Similarly the mean annual minimum and maximum rain fall extenteds from 900mm to 1587mm

2.2 Feeds and feeding management

Natural pasture hay was harvested from Pawe Agricultural Research Center at 10% flowering stage and properly dried and stored.The forage legumes cowpea and sthylosanthes humilis were planted in the research center and harvested at 50% flowering stage, properly dried and stored until begining of the experiment. All roughages were chopped using mechanical chopper about 2 to 4cm to improve feed intake.

The roughages were weighed based on the proportion given in each tretment, mixed properly and offered to the goat ad libitum as a basal diet throughout the experimental period.

White maize was purchased from pawe local market while soyanbean (variety Bellesa 95) was taken from the research center.Soyabean grain was toasted until it becomes redish brown. Both soyabean and maize were grind and mixed using feed miller in Almu poultry multiplication center. Concentrate mixture (169grm white maize and toasted soybean at propetion of 50:50) and 5% of daily feed offered molasses were given for all experimental animals based on the average body weight throughout the experimental period at 09:00 and 13:00 hours daily. Mixture of roughages were agglutinated with 5% molasses and offered twice a day including 20% refusal. Samples were taken every five day from the offered feed, pooled by treatment and properly mixed then subsampled monthly. The refusals were weighed daily, pooled by treatmeny and subsamples taken every five day. Samples were properly mixed and the representative subsamples were sent to Holleta Agricultural Research Center animal nutrition laboratory to determine the nutrient content of feed ingridents, feed offered and feed refusals. The goats had free access to clean fresh water and common salt throughout the experimental period. The roughage feeds were offered in two equal portions at 08:00 and 14:00 hours daily.

2.3 Treatments and experimental design

The experiment was conducted using a randomized complete block design (RCBD) with five treatments and six replications. The experimental goats were blocked based on their initial weight in to six blocks of five animals each. Treatment diets were randomly assigned to each animal in the treatment in such a way each animal have equal chance of receiving one of the treatment diets.

Table 1: Arrangement of experimental feed

Treatments	Basa diet	Concentrate(Maize+ Soyabean)	Substitute of 50% hay basal diet (Sthylosanthes humilis +Cowpea)	
T_1	100% hay	169g	0 % Sthylo	0% Cowpea
T_2	50% hay	169g	80 % Sthylo	20% Cowpea
T_3	50% hay	169g	70 % Sthylo	30% Cowpea
T_4	50% hay	169g	50 % Sthylo	50% Cowpea
T_5	50% hay	169g	25 % Sthylo	75% Cowpea

2.4 Animals and their management

Thirty intact yearling Gumuz male goats with an average initial body weight of 17.22kg ± 2.85 kg (mean ± SEM) were used for this experiment. The rest five goats were kept as reserve in case died or diseased during the adaptation period. The animals were quarantined for two weeks in the experimental area before commencement of aclimatization to observe healthyness of animals. After quarantine period experimental animals were aclimatized to treatment diets for fifteen days. Goats were de-wormed and sprayed against internal and external parasites, respectively before the beigining of actual experiment. They were also vaccinated against the common diseases (PPR, Pox) prevailing in the area. Expermental Animals were tagged for identification purpose and housed in individual pens.

2.5 Body Weight change and carcas evaluation

Intial body weight of the animals was taken at the beginning of the trial at the morning before providing feed and water for three days and average the records. To determine the weight trend animala were weighed using suspended Weighing scale with a sensitivity of 100 kg every 15 days throughout the experimental period.

Average daily gain (ADG) was calculated as the difference between final body weight and initial body weight divided by the number of feeding days. At the end of the feeding trial, all experimental animals were slaughtered overnight fasting. Slaughter weight (SW) was taken forthwith before slaughter. Hot carcass weight was determined by measuring the carcas after removing head, skin, fet and all vecseral organs. Rib-eye muscle area was determined by measuring and taking the average of longismusdorsi muscle at between 12^{th} and 13^{th} ribs. The rib-eye muscle was treaced on transparency paper after 12 hours freezing and the area was counted using grid paper with an area of $1cm^2$. Empty body weight was determined by reducing the gut fill from slaughter body weight. Dressing percentage was calculated on the bases of slaughter and empty body weight using the formula:

$$\text{Dressing Percentage} = \frac{\textit{Hot carcas weight}}{\text{Slaughter body weight}} \text{ X } 100 \quad (1)$$

$$\text{And} = \frac{\text{Hot carcas weight}}{\text{Empty body weight}} \text{ X } 100 \quad (2)$$

Total edible offal component (TEOC) was taken as the sum of liver, empty gut, visceral fat (kidney fat, heart fat, pelvic fatand omental fat), kidneys and tail. Total nonedible offal component (TNEOC) was computed as the sum of lung with trachea, esophagus, blood, spleen and pancreas, skin with feet, genital organ, head and total gut fill. All measurments except hot carcas weight were measured using sensitive balance weighing from 0.01mg to 8 kg.

2.6 Statistical Analysis

Data from the experiment were subjected to the analysis of variance (ANOVA) in a randomized complete block design using the general linear model procedure of SAS. Individual differences between means were tested using Tukey Honestly significance difference (HSD) test. In all the Comparisons, the level of significance was set at $\alpha = 0.05$

3. Results and Discussion

3.1 Chemical composition of experimental feeds

The DM, CP, ash, NDF, ADF and ADL contents of different experimental ingredients and grass hay are given in Table 2. Natural grass hay had lower CP and higher NDF and ADF content than the substitute sthylosanthes humilis and cow pea feeds. Sthylosanthes humilis had relatively similar crude protein content(13.9) with Sthylosanthes hamata [12] and much lower crude protein content compaired to Sthylosanthes guianensis which is 23.7 in western oromia [13] and similarly current study of crude protein content of cow pea had higher than similar variety cow pea in pawe (24.4) [14, 15]. With regard to the crude protein content of the cow, the variation might be due to season and the miniral content of land allocated during harvest.

Table 2: Chemical composition of the experimental feeds on DM basis

Feed ingredients	Chemical composition						
	DM%	Ash (%DM)	OM (%DM)	CP (%DM)	NDF (%DM)	ADF (%DM)	ADL (%DM)
Staylosantus humilis	92.89	9.45	90.55	12.78	52.75	40.25	7.30
Cowpea	90.58	8.56	91.44	27.87	45.76	24.52	3.09
Natural grass hay	93.14	8.24	91.76	5.87	64.57	44.67	10.89
Maize	92.76	8.08	91.92	15.67	59.08	42.98	7.08
Soyabean	92.78	7.87	92.13	43.67	48.90	31.02	6.14
T_1	93.14	8.17	91.83	5.92	64.90	44.94	10.81
T_2	92.79	8.74	91.26	10.84	57.99	40.86	8.67
T_3	92.68	8.69	91.31	11.61	57.63	40.07	8.46
T_4	92.45	8.60	91.40	13.12	56.93	38.50	8.04
T_5	74.19	6.96	94.04	8.98	46.24	32.37	6.85

DM = Dry Matter, OM = Organic Matter, NDF = Neutral Detergent Fiber, ADF = Acid Detergent Fiber, ADL = Acid Detergent Lignin

3.2 Body weight change and carcas characteristics

The mean initial body weight (IBW), final body weight (FBW), total body weight change (TBWC), and average daily gain (ADG) of Gumuz goat was presented in Table 3. Goats that are received T_4 which is substituted by 50% sthylosanthes humulis and 50% cow pea had higher FBW, TBWC and ADG ($P<0.05$) than the sole natural pasture hay basal diet (controlled treatment). Treatment groups that are received T_3,T_2 and T_5 had no significance difference with compared to T_1 in all parameters. Eventhough, there is no statistical difference between treatment groups of basal substitutes T_3 shows higher numerical value on FBW, TBWC and ADG The higher performances (FBW, TBWC and ADG) of goats that consume mixture of 50 % sthylosanthes and 50% cow pea substitute basal feeds as compared to sole natural hay might be due to the higher crude protien (CP) content in mixture of sthylosanthes humilis and cowpea than the natural pasture hay. However, the results of total body weight change (TBWC), average daily gain (ADG) and final body weight (FBW) were not significantly different ($P>0.05$) among treatments containing different proportions of sthylosanthes humilis and cowpea.

Table 3: Body weight change of Gumuz goat fed on substitution of natural pasture hay by mixture of stylosantus himulis and cowpea in different proportions.

Body weight change	Treatments						
	T_1	T_2	T_3	T_4	T_5	SEM	P-Value
Initial body weight (IBW) (kg)	16.70	16.53	18.13	18.17	16.57	0.72	0.27
Final body weight(FBW) (kg)	21.44^{b}	22.32^{ab}	24.84^{ab}	25.16^{a}	22.24^{ab}	0.87	0.02
Total body weight change (TBWC)(kg)	4.74^{b}	5.79^{ab}	6.71^{ab}	6.99^{a}	5.67^{ab}	0.47	0.02
Avarage daily gain (ADG) (g/day)	52.67^{b}	64.30^{ab}	74.52^{ab}	77.71^{a}	63.04^{ab}	5.18	0.02

[a, b] Meanswith a different superscript in the same row are different at $P<0.05$

[ab] Means in the same row without common letter are different at $P<0.05$

The trend in live weight change of goats over the experimental period shows consistent increase in live weight gain throughout the feeding period.

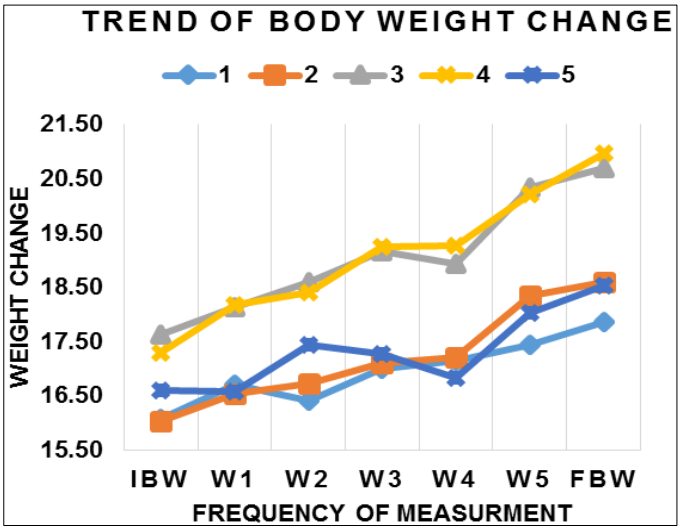

Fig 1: Trend of body weight change of Gumuz goat fed on substitution of natural pasture hay by mixture of stylosanthes himilis and cowpea in different proportions.

3.3 Carcass Characteristics

The average slaughter weight (SW) and empty body weight (EBW) were (P<0.05) no significance difference for goat substituted with different propertions of sthylosanthes humulis and Cowpea as compared to goats feed on sole natural hay basal diet (Table 4). There was variation between goats that feed on 70:30 and 50:50 Sthylosantheshumilis and cow pea substituted with Natural Pasture Hay basal diet in hot carcas weight with compared to goats that are feed on sole natural pasture basal diet.The hot carcas weight was higher in goats that feed on sthylosanthes humilis and cow pea substituted at propertions of 70:30 and 50:50 than the goats feed on sole Natural Pasture Hay basal diet.

Currerent experiment was lower than the result of [16] which is 14.8 kg grass hay based replacement of alfalfa hay in verginia, USA. In the other side,this result is higher than the result of [17] of sidama goat which was 8.8kg replacing Erythrina brucei leaf by cotton seed cake of Natural pasture hay basal diet. This was also relatively in agrement with the result [18] who reported the effect substituting mixed concentrate by dried mullebery leaf supplementation of Arsi-Bale goat which was 24.5kg. However there is no significance difference in hot carcas weight within treatment groups of goats that feed on diffent propertions of sthylosanthes humilis and cow pea substitute of basal diet.

The Dressing percentage (DP) on slaughter body weight basis in the current study was higher (P<0.05) for the goats substituted with sthylosanthes humilis and cow pea at 70:30 and 50:50 as compared to sole natural pasture hay basal diet. In the present study, the dressin percentage slaughter weight (DPSW) bases ranged between 37.05-46.31%, which is in agreement with the 36.5-44 % [19], 45.5-46.0% [20] and 46.6, 42.5, 3.7 [21] for sidama goat and Arsi-Bale goat and afar goats,Central highland goats (CHG), Long eared somalia goats (LES) goats respectively. Generally, the variations in carcass traits in this study and other results of previous studies might be due to variations in age, breed of goat and quantity and carcass traits of animals.

The rib-eye muscle area in the present study was ranged between 3.45 - 4.11 cm^2. Comparable results to this study were reported by [22], 4.8 – 7.88 cm^2, for Somali goat, [23], 5.42 - 5.75 cm^2 for Afar,CHG,LES goats and [24], 4.3-5.6 cm^2, for Local goat respectively. But higher results was reported [25] for arisi bale goat (9-9.4 cm^2) [26] (22.7, 14.4 and 18.7 cm^2) for libiyan pure breeds of Damascus, Mahali and Morcia Granada goats respectively. In the current study, there was no significant difference in rib-eye muscle area (p>0.05) between the conntroled treatment groups and sthylosanthes Humilis and cow pea substituted groups of treatments.

Table 4: Carcass characteristics of Gumuz goat fed on substitution of natural pasture hay by mixture of stylosantus himulis and cowpea in different proportions.

Variables	Treatments					SEM	SL
	T_1	T_2	T_3	T_4	T_5		
Slaughte weight (kg)	21.59	22.56	25.16	25.35	23.55	1.22	0.17
Empty body weight (kg)	17.60	18.53	20.67	21.31	19.12	1.20	0.21
Hot carcass weight (kg)	7.86^b	9.52^{ab}	11.62^a	10.74^a	10.16^a	0.54	0.001
Dressing percentage							
Slaughter weight base	37.05^b	41.92^{ab}	46.31^a	42.51^{ab}	43.33^{ab}	2.05	0.06
Empty body weight base	46.02	51.26	56.23	50.49	53.58	2.67	0.13
Rib-eye area (cm^2)	3.66	3.82	3.62	4.11	3.45	0.22	0.29

[a, b] Meanswith a different superscript in the same row are different at P<0.05

[ab] Means in the same row without common letter are different at P<0.05

3.4 Ofal component

Ofal components are given in Table 5 and 6. Ofal components are categorized into edible and non-edible based upon the culture of mutton consumption of the people and their preference in the study area. Due to differences in taste and in eating habits, what are saleable and edible

proportions of the carcass in one area of the country may not be the same for another [27]. Cited in [28].

3.5 Edible Offal Components

Edible offal components of Gumz goats fed on natural pasture hay as basal diet and sthylosathes Humilis and cow pea substituted were presented in Table 5. Heart, liver, stomach, small intestine, largeintestine, visceral fat and kidneys are considered as edible offal based on the eating habit of the study area.There was no significant difference ($p>0.05$) on all edible offals components across treatment groups and between.

Table 5: Edible offal components of Gumuz goat fed on substitution of natural pasture hay by mixture of stylosantus himulis and cowpea in different proportions

Traits	Treatments							
	T_1	T_2	T_3	T_4	T_5	SEM	p-value	CV
Heart (g)	80.67	90.58	88.58	99.50	95.92	6.11	0.27	16.43
Liver (g)	290.50	287.83	343.17	300.67	312.67	15.06	0.10	12.02
Stomach (g)	553.33	596.67	591.67	628.33	621.67	41.86	0.74	17.14
Large intestine (g)	111.92	94.17	93.42	81.17	112.17	20.75	0.80	51.57
Small intestine (g)	680.00	541.67	626.67	641.67	667.67	59.86	0.53	23.23
Visceral fat (g)	486.80	35. 20	495.30	506.80	401.30	81.56	0.63	44.45
Kidney (g)	54.83	54.167	61.00	55.83	52.83	2.64	0.26	11.59
Total edible offals (kg)	2.40	2.22	2.51	2.54	2.51	0.18	0.71	17.90

SEM = standred error mean, CV = cofficient of varience

3.6 Non Edible Offal Components

Non-edible offal component of Gumuz goats fed on Natural Pasture Hay and sthylosanthes Humilis and Cow pea substitutes are given in (Table 6). Blood, gut contents, skin, feet, genital organ, urinary blader, spleen and head components were considred as non edible offal components. Except blood weight there was no significance difference on all non edible components between treatment groups indicating that that variation in basal diet substitution of sthylosanthes humilis and cow pea intake and nutrient supplementation have no influence on non-edible offals parameters. Blood weight differ significantly between sthylosanthes humilis and cow pea basal substitute and sole natural pasture basal diet ($P<0.05$) and this showed feeding level had an effect on the weight blood. The higher blood weight (840 g) was recorded in Treatment three.

Table 6: Non-edible carcass characteristics of Gumuz goat fed on substitution of natural pasture hay by mixture of stylosantus himulis and cowpea in different proportions.

Traits	Treatments							
	T_1	T_2	T_3	T_4	T_5	SEM	P - value	CV
Blood (g)	645.00^{b}	748.33^{ab}	840.00^{a}	746.67^{ab}	676.67^{ab}	42.26	0.035	14.15
Skin (kg)	1.54	1.67	1.89	1.99	1.81	1.115	0.068	15.36
Feet (g)	539.17	551.17	572.83	594.17	562.33	19.47	0.354	8.46
Genital organ (g)	174.83	164.00	208.50	207.50	183.50	11.81	0.053	15.41
Gut contents (kg)	3.41	3.45	3.83	3.59	3.79	2.740	0.746	18.57
Urinary bladder (g)	24.083	28.917	29.000	37.417	32.250	5.32	0.508	42.97
Spleen (g)	31.250	26.000	38.583	28.833	23.917	3.75	0.095	30.94
Head (kg)	1.09	1.07	1.14	1.23	1.11	58.86	0.370	12.81
Total non-edible offals (kg)	12.375	12.533	13.830	13.520	13.557	0.614	0.363	11.42
Non-edible offal (%SBW)	68.210	65.785	64.223	62.037	68.145	3.429	0.67	12.79

[a, b] Meanswith a different superscript in the same row are different at $P<0.05$

[ab] Means in the same row without common letter are different at $P<0.05$

SEM = standred error mean, CV = cofficient of varience

4. Conclusion

The experiment was conducted to evaluate the effect of sthylosanthes humilis and cow pea substitution to sole natural pasture hay as basal diet at a ratio of 80:20, 70:30, 50:50 and 25:75 on feed intake, digestibility, body weight (BW) change and carcass characteristics parameters of Gumuz yearling goats. The main purpose was to evaluate the response of different proportions of cowpea & stylosantus himiulis as basal diet substitute supplement and generate information about the feeding efficiency of these legume forages for goat.

Thirty intact male Gumuz goats with average initial BW of 17.22 ±2.85 kg was used for the experiment in a randomized complete block design (RCBD) with six blocks each consisting of five goats. The blocks were established based on initial body weight of the goats and the goats within each block were randomly assigned to one of the five treatment diets. Animals had free access to mineral block and water. After the quarantine period of fifteen days of adaptation period, feeding trial were conducted for 90 days, with measurements of carcass parameters at the end. Intake, body weight initially and every 15 days, chemical composition of feed and carcass characteristic were measured.

The results indicated that legume substition on basal diet have positive effect on growth and carcass characteristics of gumuz goats. Carcass parameters (slaughter weight, empty body weight, hot carcass weight, dressing percentage and rib-eye area) were higher for goats received with 70:30 and 50:50 sthyloasnthes humilis and cowpea ratio basal diet substitution than sole natural pasture hay basal diet. However Goats supplemented with 80:20 sthylosantes humilis and cowpea ratio as basa diet substitutes was show similar results of carcass parameters with those which fed with sole natural pasture as basal diet.

Therefore it was concluded that substituting 50:50 sthylosanthes humilis and cowpea ratios were increase carcas parameter Gumuz goat yield. Alternatively, substituting 70:30 sthylosanthes humilis and cowpea as basal diet could be recommended because of their similar effects on the growth and carcass parameters of Gumuz goat

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