JIMMA UNIVERSITY COLLEGE OF AGRICULTURE AND VETERINARY MEDICINE

Effects of replacing Concentrate mix with different levels of *Erythrina brucei* (*korch*) leaves on Nutrient Intake, Digestibility and Body Weight Gain of Bonga Sheep fed a basal diet of *Pennisetum glaucifolium* (desho grass)

Thesis Submitted to Department of Animal Science in Partial Fulfillment of the Requirement for Degree of Master of Science in Animal Production

By

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DEDICATION

This thesis is dedicated to my cherished family for their enthusiastic participation in my life's success.

STATEMENT OF THE AUTHOR

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BIOGRAPHICAL SKETCH

The author, Mengistu Alemu was born on May 31, 1989, in Gewata District, Kafa Administrative Zone, Southwest Peoples Regional State. He attended his elementary education in Kobech Primary School. He continued his high school studies at Gimbo Senior Secondary School and completed at Bonga Complete Secondary School. After successful completion of the Ethiopian Higher Education Entrance Qualification Certificate, he joined Debre Markos University in the 2008/09 academic year and graduated with B.Sc. Degree in Animal Science on July 02/2011.

Soon after his graduation, the author was employed and worked in different expert and leadership positions at Southwest Peoples Regional State, Kafa Zone, Gewata District Agriculture, Natural Resource, Livestock & Fishery, and Party offices until he joined his MSc study.

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LIST OF ABBREVIATIONS

CSA	Central Statistics Agency
SNNPR	Southern Nation Nationality People Regional State
MJ	Mega joules
ME	Metabolizable energy
Kg	Kilogram
DM	Dry matter
CP	Crude protein
NRC	National Research Council
DOM	Digestible organic matter
FAO	Food and Agricultural Organization
NDF	Neutral detergent fiber
ADF	Acid detergent fiber
ESGPIP	Ethiopia Sheep and Goat Productivity Improvement Program
OM	Organic matter
˚C	Degree Celsius
Masl	Meter above Sea Level
cm	Centimeter
RCBD	Randomized Complete Block Design
EBDL	*Erythrina Brucei* dried leaves
CM	Concentrate mixture
FCE	Feed conversion ratio
DMI	Dry matter intake
ADL	Acid detergent lignin
DOMI	Digestibility of organic matter intake
DMRT	Duncan's Multiple Range Test
SAS	Statistical Analysis System
TVC	Total variable cost
TR	Total Revenue
NI	Net Income
ETB	Ethiopian Birr

MRR	Marginal Rate of Revenue
GLM	General Linear Model
ANOVA	Analysis of Variance

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ABSTRACT

Shortage of feed-in quantity and quality are the major setback for livestock production and productivity in Ethiopia since there is a huge livestock population in the country. The unavailability and increment of commercial mix cost have been significantly affecting the cost of livestock production. Attempts have been made to exploit locally available indigenous feed resources as a sustainable solution to enhance livestock productivity among smallholder farmers. Erythrina Brucei (EB) is a perennial woody leguminous tree with great forage potential to supply adequate amounts of nutrients to ruminants especially in the dry season when there is chronic feed shortage.

The feeding trial was carried out to determine the optimum level of EB leaves for replacing concentrate mix (CM) and its effect on feed intake, digestibility, and weight gain performance of Bonga sheep fed Glocifolium pedicellatum (GP) hay as a basal diet. Forty-two (42) intact male local lambs with an initial weight of 20.08+1.06 kg were divided into six groups of seven animals in a randomized complete block design (RCBD). Treatments comprising of T1=ad libitum GP, T2= ad libitum GP + 100% EB, T3=ad libitum GP + 75%EB+ 25% CM, T4= ad libitum GP+50%EB+50%CM, T5=ad libitum GP+25% EB+75% CM and T6=ad libitum GP+0% EB+ 100% CM were randomly assigned to each lamb within the group. The data were analyzed using the general linear model (GLM) procedure of SAS (version 9.3, 2002).

The nutrient composition of EB leaves is a potential source of dry matter DM (93.6%) and crude protein CP (28.3%). The supplementation of 50% of EB leaves significantly ($p<0.001$) increased DM, OM, CP and ME intakes among treatments. Supplemented sheep consumed more ($P<0.05$) by the proportion of the supplements total DM and organic matter (OM) than the non-supplemented group, but the intake was not influenced ($P>0.05$) by the proportion of the supplements. The highest ($P<0.05$) crude Desho was the non-supplemented group. There is a significant difference ($P<0.001$) in terms of average daily gain (ADG) except T1 which fed GP ad libitum in which the lowest performance was observed.

1. INTRODUCTION

1.1 Background of the study

Ethiopia is believed to have the largest livestock population in Africa. Among the diversified livestock species, sheep production is a major component of livestock farming in Ethiopia and it is mostly kept by smallholders and the rural poor, including women-headed households (Haile *et al*., 2019). About 31.30 million sheep populations are estimated to be found in Ethiopia (CSA, 2018). Sheep contribute substantially to the livelihoods of smallholder households as a source of income, food, and raw materials (Negassa and Jabbar, 2008). They also serve as a means of risk mitigation during crop failures, savings, and investments in addition to other socio-economic and cultural functions. In terms of breed compositions, about 99.81 percent of sheep in Ethiopia are indigenous breeds (CSA, 2018). Of these diverse indigenous sheep breeds, at least 9 breeds and 14 traditional sheep populations are distributed across diverse ecology, production systems, and communities in Ethiopia (Gebremariam, 2019).

Bonga sheep, one of the well-known and largest breeds of Ethiopia, is characterized by long and wide fat tails with tapering and twisted ends, both males and females are polled, with short and smooth hair, mainly convex facial profiles of male and predominantly light red coat color. The breed is known for its docile temperament, good fattening potential, fast growth, and prolificacy (Gemeda D *et al.,* 2010). This breed was specifically native to the Kaffa zone of Southern Ethiopia (Mamru M *et al*., 2017a). The price of Bonga sheep is high as compared to other breeds, both for breeding and fattening purposes in Ethiopia (Gutu *et al*., 2015). This breed was found in humid and mid-highland (1200–2500 meters) ecological zones that are geographically distributed in the Kafa, Sheka, and Bench zones of SNNPR (Gizaw S *et al*., 2007 & Edea Z, 2008).

In Ethiopia, despite having a good number of sheep the productivity is very low as explained by the annual off-take rate of 33% and the average carcass yield weight for Ethiopian sheep is 10 kg which is lower than the neighboring African countries sheep carcass weight such as Sudan (12 kg); Kenya (13 kg) and Djibouti (14 kg) (Thorpe W.R *et al*., 2010). This low productivity of animals could be caused by many factors like feed deficit, the low genetic potential of sheep, and the prevalence of disease, but a shortage of feed in terms of quality and quantity is the critical one in the country (Getahun K, 2015). Likewise, in cattle production, most of the sheep feed in Ethiopia

is derived from natural pasture, and crop residues (Addisu E *et al*., 2016). However, such feed resources may not fulfill the nutritional requirements of animals, particularly in the dry season (Yirga M *et al.*, 2017). Feeding such poor nutritional value feeds results in slow growth rates, poor fertility, and high rates of mortality and consequently reduced the productivity of sheep (Berhanu A *et al.*, 2014). The other constraints related to nutrition and feeds in Ethiopia are, mainly due to the small land size and overstocking brought about by the shrinking amount of land reserved for grazing and the low feeding value of available feed resources resulting in low efficiency of utilization (Abule Ebro, 2015). This is aggravated by the seasonal availability of forage and crop residues in the highlands and by recurrent and prolonged drought in the lowlands (Tekleyohannes B *et al*., 2017).

The lowest energy density at which sheep do not lose weight is between 8 and 10 MJ ME/kg DM and the minimum protein level required for maintenance is about 8% crude protein (CP) in the DM. However, most productive animals such as rapidly growing lambs and lactating ewes need about 11% CP in the DM (NRC, 1985). Hence, the protein levels in feed resources such as grass hay harvested from natural grazing land and crop residue from cropping activities are considerably lower than the requirements. These feed resources are generally characterized by low digestibility (<500g DOM/kg DM) due to the close association of carbohydrates with lignin.

Therefore, strategic supplementation of these feeds with grains or agro-industrial by-products was also recommended (McDonald *et al*., 2010). However, supplementing these feedstuffs with concentrates and agro-industrial by-products is very expensive, not accessible, and even not affordable for most smallholder farmers since concentrate mix feed resources, especially grains, are highly valued as human food. Thus there is a great need to explore alternate feed resources that could not compete with human food and boost the feeding values of low-quality roughages. Therefore using fodder like *Erthrina Brucie* has high forage potential and can effectively serve as a cheap source of protein supplement for low-quality diets during the dry season for resource-poor farmers with stall-fed sheep (A.Larbi *et al*., 1993). Protein source potential *Erythrina brucei* leaf can be an alternative CP supplement for concentrate mixtures which are inaccessible to some part of smallholder farmers in our country. Sheep in Kafa zone were owned by smallholder farmers as an integral part of the livestock sub-sector besides its contribution to both subsistence and cash income generation. Thus, the objectives of this paper were to characterize the Bonga sheep

performance by identifying major feeding and management practices in Kafa zone southern Ethiopia.

1.2 Statement of the problem

It was known that shortage of quantity and quality of feed is the major constraint of livestock production in sub- Saharan Africa Particularly in Ethiopia. Both protein and energy are the major factors affecting the productivity of small ruminants because animals live predominantly on high fiber feeds, and poor-quality roughages feed resources which are often deficient in nutrients. Also, these feeds are inherently low in nutritive value such as protein and digestible energy, which are low in palatability, digestibility even do not meet the maintenance requirements of animals mostly in the dry season. This results in poor reproductive performance of animals, loss of body weight, retarded growth rate, and increase susceptibility to diseases. So, to mitigate the feed challenges supplementation with improved fodder shrubs like *Erythrina brucei* can be more important for use as high-quality forage for sheep feed. It can satisfy the nutritional requirements of sheep throughout the year. Therefore, this study was conducted to evaluate the supplemental feeding value of Erythrina Brucei dried leaves by substituting concentrate mixture (Noug seed cake and wheat Bran) which do not cost-effective and not widely accessible for smallholder farmers in the study area.

1.3 Purpose of the Study

The purpose of this study is to evaluate locally available leguminous feed resources in terms of intake, digestibility, and weight gain response on Bonga sheep breeds that are known for their high-performance ability even on the low input management system. Feed resources may not fulfill the nutritional requirements of animals, particularly in the dry season due to either being unavailable in sufficient quantities, inherent low nutrient content because of fluctuating weather conditions or poor quality. So, this study drives us towards efficient use of locally endowed forage legumes for the improvement of product and productivity of the Bonga sheep breed.

1.4 Questions and/or Hypotheses

The productivity of the Bonga sheep breed is largely constrained by feed shortage and poor management. Feed intake and weight gain are important parameters in determining the efficiency of animal production. This paper summarizes the results of feeding trials with Bonga sheep in

Kaffa. The primary objective of these experiments is to measure feed intake, digestibility, and weight gain of Bonga sheep fed on hay, or hay plus various levels of concentrates with supplementation of *Erythrina brucei*. The sheep producers are benefitted from a vast range of products from their flock, which are both tangible and intangible. Therefore, there are a lot of constraints to achieve the expected goal to farmers through inefficient feed resources and poor management experience on sheep. From here there are variables that we call "independent variable" /feed/ that plays a great role to achieve the efficient performance of sheep following "dependent variables" like digestibility and weight gain.

Therefore, this study is going to check whether it affects Bonga sheep by feeding a different mix of rations of desho grass hay, concentrate and *Erythrina brucei* feed sources.

1.5 Objective of the Study

General Objective

The general objective of this study will to evaluate Korch /Erythrina brucie/ dried leaves as a substitution for concentrate mixture supplement on intake, digestibility & growth/weight gain/ characteristics of Bonga sheep fed on desho grass hay as a basal diet.

Specific Objective

- To evaluate the effect of *Erythrina brucei* dried leaves on feed intake, nutrient digestibility, and weight gain
- of Bonga sheep fed on Desho grass hay as basal diet.
- To evaluate growth performance of Bonga sheep fed on Desho grass hay as a basal diet supplement with *Erythrina brucei* dried leave and concentrate mix with d/t proportions.
- To identify optimum level of substituting EB leaves with concentrate mix to Bonga sheep

3. MATERIAL AND METHODS

3.1 Description of the Experimental Area

The experiment was conducted at the Modiyo sheep research Center, Decha woreda, kaffa zone, Ethiopia. It is located 465 km and 15 km far from Addis Ababa the capital city of Ethiopia and Bonga Administrative city of kafa zone respectively. Geographically it is located at 7° 26′ N and

36° 47′ E with an elevation of 1867 masl. The average daily minimum and maximum temperatures were 14 and 17˚C respectively. The average annual rainfall ranges were from 1600 to 2200 mm. The main rainy season was from April to November. The soils were dominantly Clay loam.

3.2 Feeds Preparation and Feeding

The basal diet was desho grass (*Pennisetum glaucifolium*) hay which will harvest from the Modeyo kebele. The desho grass hay needs chopping manually to the size of approximately 5–10 cm to facilitate feed intake, palatability, minimize feed wastage, and selection by experimental sheep. The grasses have thoroughly mixed to reduce any variation when fed during the experiment and stored under shade to maintain their quality. The sheep will offer a uniform mix of *ad libitum* at a 20% refusal rate provided with free access to clean water throughout the experimental period.

The amount of feed offered is to be adjusted every day by measuring leftover and based on the feed consumption by allowing 25% based on the previous day's intake. The requirement amounts of supplement feed Noug seed cake (NSC) and wheat bran (WB) were purchased from oil extracting and Addis Ababa flour milling factory respectively, mixed at a ratio of 40%NS and 60% WB offered at the graded level of replacement. The *Erythrina brucei* (EA) dried leaves are purchased from the farmers around Modeyo PA, kafa zone southwest Ethiopia and were transported to the experimental site and become dry under the shade. Enough amounts of feeds for the entire experimental period have been prepared before the actual experiment commences. The concentrate supplement, i.e., Noug seed cake and wheat bran formulation be done based on the iso-nitrogenous basis in crude protein content 1:2 ratio. In addition, concentrate mix and *Erythrina brucei* dried leave ration will going to make based on their crude protein contribution nearly the same level for all treatments except control group which fed only the basal desho diets. The concentrate was mixed in a way that the CP content of the mixture is on average 18 % CP on a dry matter basis for the fulfillment of the protein requirement of growing sheep with a bodyweight of 15-20 kg (Ensiminger, 2002). The diet was provided twice daily in equal proportion at 8:00 am and 6:00 pm after the provision of the basal diet in a separate feed trough.

3.3 Experimental Animals and their Management

Intact yearlings of 42 male Bonga sheep with similar initial body weight will have to purchase from Bonga sheep breed improvement cooperatives involved in community-based sheep

improvement located at 35 Km from Bonga town. The age of the sheep may be estimated based on dentition and information obtained from the owners of the sheep (seller) during purchasing. The experimental animals get ear tags for identification and are quarantined for 15 days at a standard sheep barn with feeding and watering troughs in the study area to adapt to the environment, pen management, and diets. Meanwhile, during the quarantine period, sheep need a vaccine against ovine pasteurellosis and have to be injected with multi-vitamins based on the prescription of veterinarians from employers of Bonga Research Center. The sheep have also taken deworm against internal parasites using albendazole and ivermectin for ectoparasites respectively. Animals are arranged in a block based on their initial body weight into 6 blocks of 7 animals each and have to be placed in individual pens equipped with a feeding trough for desho grass hay and plastic buckets for watering and dried *Erythrina brucei* leaves with concentrate mix. Experimental animals were allowed for adaptation periods of 15 days before actual data collection to adapt experimental diet and experimental procedure. The experimental animals need careful observation for the occurrence of any ill health and records to become taken for any physiological disorder during experimental periods.

3.4 Experimental Design and Treatments

The experiment was conducted in a randomized complete block design (RCBD) with six treatments with seven replications. The sheep were divided into Seven blocks based on their initial body weight and each sheep within each block will be randomly assigned to one of the six dietary treatments by using the lottery method. The initial body weights of ram were determined as a mean of two consecutive weighing after overnight fasting at the beginning of the acclimatization period. The dietary treatments that we have to use in the growth trial are presented in (Table2).

Table 1 Experimental treatments used in a growth trial

Treatments	Desho grass hay	*Erythrina brucei* (%)	Concentrates Mix (%)	EBDL (g/DM/Day)	CCM (g DM/Day)	N
T1	ad libtum	0%	0%	0	0	7
T2	ad libtum	100%	0%	1000	0	7
T3	ad libtum	75%	25%	750	125	7
T4	ad libtum	50%	50%	500	250	7
T5	ad libtum	25%	75%	250	375	7
T6	ad libtum	0%	100%	0	500	7

EBDL = *Erythrina brucei* Dried Leave; CCM=Concentrate Cake Mixture (Noug seed cake & Wheat bran).

3.5 Feeding Trial

At the feeding trial, daily feed offering and corresponding refusals for each sheep was come collected and recorded from each treatment throughout the experimental period (90 days). Daily mean feed intake has to be measured as differences between offering and refusal. The sheep will offer *ad libitum* desho gras*s* hay, at 20% refusal to make sure animals are fed *ad libitum* throughout the experimental period. Samples of feed offering have to be collected per batch while samples of refusal were taken from each sheep daily and pooled per treatment over the experimental period and it was stored in plastic bags that we use for chemical analysis.

Measurements and Observation

Dry matter intake

Following the quarantine period, and after an acclimatization period of 15 days to the experimental pens and diets, the feeding trial was conducted for 90 days. Feeds were offered at 08:00 hours and 16:00 hours into equal portions and water was offered free choice. Daily feed was offered to the experimental animals and the corresponding refusal of every animal was measured and recorded during the experimental period. Both basal and supplement diets were offered separately, and intake was determined by the difference between the amount of feed given and refused every day (24 hours) on DM basis. Samples were taken from batches of feed offered and orts, thoroughly mixed, and sub-sampled (10%) for dry matter analysis. The sub-samples were kept frozen (-20 $^{\circ}$C) until analyses.

Body weight change and feed conversion efficiency

The bodyweight of the animals was taken at the beginning of the growth trial after overnight fasting and every 10 days during the 90 days of the growth trial. All animals have to be weighed in the morning hours after overnight fasting before feed provision using a weighing balance with a sensitivity of 50 grams. The initial body weight of animals is determined by taking the mean of two consecutive weights, and the final body weight was taken at the end of the experiment. All bodyweight measurements have to be taken after overnight fasting. Average daily body weight gains (ADG) were calculated as the difference between final live weight and initial live weight divided by the number of feeding days. Feed conversion efficiency (FCE) which is the measure of feed utilization was estimated in the experimental period. According to Gulten *et al.* (2000) and

Brown *et al.* (2001), the feed conversion efficiency (FCE) of experimental animals was determined by dividing the average daily body weight gain by the amount of feed consumed.
The metabolizable energy intake (MEI) (kJ/kg $BW^{0.75}$) was estimated according to (McDonald *et al*., 2002).

Bodyweight gain, average daily body weight gain, and feed conversion efficiency was calculated as follows:

Weight gain = final body weights - initial body weights

$$\text{Average daily body gain} = \frac{\text{Final body weights} - \text{Initial body weights}}{\text{Number of feeding days}}$$

$$\text{FCE} = \frac{\text{Daily body weight gain (g)}}{\text{Daily feed intake (g)}}$$

3.6 Digestibility Trial

The digestibility trial of the treatments diets was conducted using all experimental animals at the end of the feeding trial for ten days. The experimental animals will allow adapting harnessing of fecal collection bags for three days before data collection. The actual data collection will proceed for seven days. The daily feed offered and refused and fecal outputs were measured for each animal based on DM basis. Dry matters of the fecal output have to be determined daily. Representative fecal samples (10% of total fecal production) are dried at 65°C for 72 hours to constant weight in a forced draft oven for DM determination. At the end of the collection period, the subsamples of partially dried feces were pooled from each animal, and a 10% subsample was ground to pass through a 1mm sieve and stored in an airtight polyethylene bag pending analysis. The chemical analysis was conducted at the animal nutrition laboratory of ILRI. Apparent digestibility of DM, OM, CP, NDF, and ADF was determined as a percentage of the nutrient intake not recovered in the feces using the following equation [20]:

$$\text{Apparent nutrient digestibility coefficient} = \frac{\text{Nutrient intake} - \text{Faecal nutrient output}}{\text{Nutrient intake}} * 100\%$$

$$\text{Apparent DM digestibility coefficient} = \frac{\text{DMI} - \text{Faecal DM output}}{\text{DMI}} * 100$$

Where: DM = dry matter; DMI = dry matter intake

3.7 Chemical Composition Analysis of Feed and Fecal Samples

The chemical composition was conducted to analyze the chemical composition of the experimental feed offered, refusal and feces were carried out after taking the representative samples and oven at 65^0 C for 72 hours. Samples of feed offered, refusals and feces will grind to pass a 1 mm sieve mesh and kept in an airtight plastic bag, and transported to ILRI nutrition laboratory to determine Ash, OM, CP, and partial DM content of feeds. The dry matter content of the feed was determined by drying the samples at 105°C overnight and ash by burning/igniting the samples at 550°C for 5h the oven according to the procedures of (AOAC, 2005). Nitrogen will extract with the Keldjhal method and then the crude protein (CP) can be calculated as nitrogen by multiplying the N content of the sample with a conversion factor of N ×6.25.

Neutral detergent fiber, acid detergent fiber (ADF), and acid detergent lignin (ADL) was analyzed according to the procedures of (Van Soest and Robertson, 1985). The organic matter (OM) content was calculated as the difference between DM and ash content. The energy value of feed was estimated according to McDonald *et al*., (2010) as metabolizable energy (MJ/kg DM) = 0.016 DOMI; where DOMI being digestible OM intake per kg DM.

3.8 Statistical Analysis

The data obtained on feed intake, digestibility, body weight change, and feed conversion were subjected to analysis of variance (ANOVA) using the general linear model (GLM) procedure of SAS (Statistical Analysis System) 2014 version 9.4 and R . Analysis of variance among the treatment means, least significance diffrence (LSD) will to test and locate the treatment means that significantly differ from the rest. The following model was employed to analyze the data:

Models: - $Yij = \mu + ti + bj + eij$

Where Yij = response variable (an observation in i treatment and j block)

μ = the overall mean

ti= treatment effect (T1-T6)

bj= block effect (initial body weight effect)

eij = random error

4. RESULT AND DISCUSSION

Chemical Composition of the Treatment Feed

The chemical composition of the treatment feeds components used in the present study is given in Table 2. Though hay was made from mature desho grass (*Pennisetum glaucifolium*), its CP content (7.04%) was relatively similar to tropical feeds commonly available during the dry season (Tegegne and Assefa, 2010). The CP content of desho grass was sufficient for the maintenance of body weight and to maximize digestibility of DM and PDF of straw-based diets (Van Soest 1994; McDonald et al. 2002). Diriba et al. (2013) who reported around the current study area, reported higher values of DOMD, ADF, NDF, and ash ranging in percentage from 59.3 to 61.5, 39.7 to 50.3, 55.7 to 72.1, and 9.5 to 10.1%, respectively. But, a relatively lower level of ADL (5.4 to 6.5%) and CP (5.2 to 6.4%) and comparable level of DM (90.2 to 93.7%) was also reported by the same authors.

The CP content of the *Erythrina brucei (*20.3% DM) was within the range of CP (20.7–28.5 % DM) reported for nine ILCA accessions (Larbi et al. 1996) also comparable with CP in concentrate mix which are used as protein supplements in Ethiopia (Bediye et al. 2007). However, the CP content of E. brucei was higher than those reported for *Erythrina abyssinica* (Larbi et al. 1993; Kaitho et al. 1998) and Erythrina Burana (Kaitho et al. 1998). The variation in CP content of the leaves might be due to the age of the tree, stage of harvest, stage of leaf growth, the season of harvest, soil fertility, species, and variety of Erythrina as reported by Maasdrop et al. (1999) for different forage types.

The high CP content of E. brucei leaves implies that it could use as a good source of protein supplements to poor quality roughages for goats for smallholder farmers This is critical in conditions where the main limiting issue for sheep production is a deficiency of N in basal feeds such as cereal; crop residues are vital to feeding resources in (Tolera 2007).

Table 2 Chemical composition of feed used in the experiments

Feeds	Chemical composition and IVODM (DM%) of experimental feeds							
	DM	OM	CP	NDF	ADF	ADL	ME	IVODM
PGH	92.5	85.0	7.04	69.2	44.9	5.4	5.9	50.7
EB	94.1	87.7	20.3	18.1	15.7	7	9.5	68
CM	92.6	89.4	22.6	36.2	21.8	3	10.9	78
T1	93.7	90.0	7.3	73.8	46.7	5.9	7.2	51.2
T2	93.1	86.0	22.4	38.8	31.5	12.0	7.3	55.5
T3	93.1	86.6	22.3	38.7	31.1	11.5	7.4	56.2
T4	93.0	85.5	20.2	40.1	30.2	10.7	7.4	55.8
T5	92.9	86.6	17.0	41.7	28.4	8.8	7.6	55.9
T6	93.7	90.0	7.3	73.8	46.7	5.9	7.2	51.2

PGH= Pennisetum glaucifolium hay, EB= Erythrina brucei CM= concentrate mix; DM = dry matter; CP= crude protein; NDF= neutral detergent fiber; ADF= acid detergent fiber; ADL= acid detergent lignin; OM= organic matter; DOMD = digestible organic matter in dry matter; ME = metabolizable energy, IVODM=invitro Organic matter digestibility

Feed and Nutrient Intake

The amount of feed and nutrient intake of Bong sheep supplemented with different levels of *Erythrina brucei* as a replacement of concentrate mixture is presented in Table 3. The findings show that the lowest ($P<0.05$) hay DM intake was observed for the sheep receiving non supplemented diets. However, there are no significant differences among the sheep fed graded levels of *Erythrina brucei.* Supplemented treatment groups consumed more ($P<0.05$) total DM and OM than the control group.

The finding in this study in line with Larbi et al. (1993) that supplementation with legumes increased total DM and OM intake was consistent also showed increased intake of OM with higher levels of Erythrina sheep feeding. Observations by Aregheore and Perera (2004) also indicate that there was an improvement in intake through supplementation of *Erythrina variegata* in animals fed on a basal diet of maize stover.

Table 3 Feed and nutrient intake of Bong sheep fed desho grass hay supplemented with different levels of Erythrina brucei as a replacement of concentrate mixture

Parameters(g/d)	**Treatments**							
	T1	**T2**	**T3**	**T4**	**T5**	**T6**	**SEM**	**P**
Basal DMI	522.2	525.7	531.8	541.2	524.3	540.5	10.3	***
Supplement DMI	-	300.8	325.3	319.7	348.3	358.6	8.4	***
Total DMI	522.6	791.3	812.8	874.4	876.6	885.1	25.8	***
OMI	491.9	685.2	756.2	776.3	785.1	783.7	18.6	***
CPI	39.4	105.0	110.8	111.8	125.1	134.7	2.0	***
NDFI	434.4	400.1	384.7	373.6	372.4	379.6	10.2	ns
ADFI	256.6	172.7	184.3	197.1	24.1	204.1	8.6	ns
ADLI	42.1	43.7	41.4	42.5	41.8	41.3	2.0	ns
MEI	6.9	8.5	7.7	8.6	8.6	8.1	1.3	***

ADF acid detergent fiber, BW body weight, CM concentrate mixture, CP crude protein, DMI dry matter intake, NDF neutral detergent fiber, OM organic matter, MEI metabolic energy intake SL significant level

Apparent Nutrient Digestibility

The Apparent digestibility coefficients of nutrients in sheep fed erythrina Brucie as a replacement of concentrate mixture is presented in table 4.

Table 4 Table 4 Apparent digestibility coefficients of nutrients in sheep fed erythrina Brucie as a replacement of concentrate mixture.

Parameter	T1	T2	T3	T4	T5	T6	SEM	SL
DMD	58.7	67.4	68.3	69.5	69.9	71.6	1.8	***
CPD	60.0	62.0	61.9	64.7	65.1	66.9	1.4	***
NDFD	42.9	42.6	44.3	44.0	44.1	46.0	1.2	ns
ADFD	39.7	38.5	38.8	38.9	39.1	39.9	1.3	ns

DMD dry matter digestibility, OMD organic matter digestibility, CPD crude protein digestibility, NDFD neutral detergent fiber digestibility, ADFD acid detergent fiber digestibility; SEM standard error of mean; SL significance level, ns nonsignificant

Apparent DM and OM digestibility were higher (P<0.05) in DM and OM digestibility among the supplemented sheep. The digestibility of CP was higher (P0.05) among all treatment groups which is similar to the finding of Aregheore and Perera (2004) observed an improvement in the digestibility of nutrients through supplementation of Erythrina in animals fed a basal diet of maize stover. The highest digestibility of CP in the supplemented sheep could be due to the higher CP

intake compared with the non-supplemented groups which may be due to the very low content of condensed tannins (1 g/kg DM) for Erythrina species (Kaitho et al. 1998).

Bodyweight Gains and Feed Efficiency

The supplemented groups achieved higher final body weight than Hay (control) treatment, but values for the supplemented treatments did not differ from each other. Bodyweight gain, average daily weight gain, and feed conversion efficiency follow a similar trend and values were in the order of Commercial Concentrate>EB>Hay.

The current finding is similar to Larbi et al. (1993) who observed a linear increase in BW gain in sheep and goats with increasing levels of E. abyssinica leaf supplementation to the basal feed of grass hay with better response in sheep. The improvement in average daily gain (ADG) in the supplemented goats could be explained by their high total DM and CP intake.

Table 5 Body weight gain and feed conversion efficiency of Bonga sheep fed on graded level of Erythrina brucei as replacement of commercial mixture

Parameters	**Treatments**						SEM	SL
	T1	T2	T3	T4	T5	T6		
IBW (Kg)	25.7	25.1	25.3	25.2	25.4	25.3	2.37	ns
FBW (Kg)	32.0	36.4	36.7	37.0	39.7	40.9	2.01	***
ADG(g/day)	70.0	125.6	126.7	131.1	158.9	173.3	4.06	***
FCE	0.13	0.16	0.16	0.15	0.18	0.20	0.01	***

ADG average daily gain, BWC body weight change, FBW final body weight, IBW initial body weight, FCE feed conversion efficiency; SEM standard error of the mean; SL significance level, ns nonsignificant

5. CONCLUSION AND RECOMMENDATION

- Based on the above findings with 28.2% CP, the local indigenous forage *Erythrina brucei* can be considered as a medium protein feeds. As it is available in the locality of the farmers in the study area, can replace other commercial protein supplements which are too expensive and not affordable by low-income farmers.
- The natural grass hay is a poor-quality feed. This underlines the necessity of supplementary feeding for animals depending on such grasses as a sole roughage.
- The graded replacement with concentrate mix significantly improved DM/nutrient intake and digestion and growth performance of the experimental animals.
- *Erythrina brucei* has a feeding potential similar to concentrate mix (CM) and can replace CM in 1:1 ratio as a supplement to sheep fed a basal diet of grass hay

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