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Effects Of Supplementation with Sycamore Fig (*Ficus Sycomorus*) on Performances of Washera Sheep Fed Natural Pasture Hay and Its Economic Benefit

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ABSTRACT

The experiment was conducted to evaluate the effect of supplementations with F. sycomorus leaf, fruit and their mixtures on intake, digestibility, body weight gain and carcass parameters of sheep fed basal diet hay, and to assess the economic benefit of the supplementation using partial budget analysis. The experiment was carried out at Gish Abay in Sekela Woreda, West Gojjam Zone; using twenty intact male yearling Washera sheep with a mean (±SD) initial body weight of 17.5±0.39kg. The animals were vaccinated against anthrax and pasteurellosis, dewormed and sprayed against internal and external parasites, respectively, before the start of the experiment. Experimental sheep were adapted for 15 days to the treatment feeds. The experiment consisted of digestibility trial of 7 days and feeding trial of 90 days. The experiment was laid out in a randomized complete block design (RCBD) with five blocks consisting of four animals per block based on their initial body weight. Dietary treatments were randomly assigned to one of the four treatment diets within a block. Treatments comprised of feeding natural pasture hay ad libitum (un-supplemented: T_1) or natural hay supplementation with either F. sycomorus leaf (Treatment 2: T2), or F. sycomorus fruit (Treatment 4; T4), or mixture of F. sycomorus leaf and fruit in a ratio of 1:1(Treatment3; T3). The amount of supplements offered was 300 g/day on DM basis. Water and salt were available free choice. Natural pasture hay in the current study contained 8.0% crude protein (CP), 73.1% Neutral detergent fiber (NDF) and 43.6% acid detergent fiber (ADF). Sheep in the un-supplemented treatment consumed higher (p<0.001) basal dry matter intake ((581.6 g/day) as compared to supplemented group. However, total DM intake was higher for sheep in the supplemented group (T2-T4) compared to the un-supplemented (control). Supplementation significantly improved digestibility co-efficient of DM, organic matter (OM) (P<0.001) and CP (P<0.001). Supplementation highly increased (P<0.001) final body weight (FBW), feed conversion efficiency (FCE) and average daily gain (ADG). Sheep supplemented with T2 had significantly higher (P<0.001) FBW (21.6 kg), FCE (0.062) and ADG (45.1g/day) as compared to the un-supplemented treatment, which had 18.2 kg, 0.01 and 8g/day, respectively. Furthermore, Sheep in T_2 had significantly higher (P<0.05) body weight change compared to the un-supplemented. Similar to biological performance, economic analysis also showed that supplementation with T_2 resulted in better return compared to others. Thus, it can be concluded that supplementation in general improved animal performance. Among the supplements, however, T2 is biologically optimum and economically feasible.

Keywords: Average daily gain, partial budget analysis, Economic benefit, Feed Intake, Feed conversion efficiency and Washera sheep.

INTRODUCTION

Ethiopia is home for diverse indigenous sheep populations, which are estimated to be 26.1 million (CSA, 2009). There are about 14 traditional sheep populations in Ethiopia (Solomon *et al.*, 2007). Dangla (Washera) sheep is one of the traditional sheep found in West and East Gojjam Zone of the Amhara National Regional State extending to the south of Lake Tana. Washera sheep weigh about 2.8 and 13.8 kg at birth and weaning; respectively. The growth rate after weaning is comparable and even better than some other indigenous breeds. This indicates the potential of this breed for commercial mutton production for the local and export market (Kassahun and Solomon, 2008).

Despite the large population, productivity of Ethiopian livestock in general is not appreciable, mainly due to technical and non-technical constraints (EARO, 2001). Among the technical constraints, poor nutrition both in terms of quantity and quality, diseases and low genetic potential hinder animal productivity in the country. Feed shortage particularly during dry season; limit the animal output in most part of the country (Alemayehu, 2005). The available feed resources cannot meet the nutritional requirements of animals throughout the year in many parts of the country either due to inadequate supply or quality of the feed (Adugna, 2008). Livestock feed resources in Ethiopia are mainly natural grazing and crop residues, which are low in energy and protein leading to significant limitation in the productivity of sheep (CTA, 1991). Such feed deficiencies causes loses of weight gains made during more favorable periods, while fodder conservation to help eliminate seasonal feed supply fluctuations are rarely practiced (Alemayehu, 1995). As result, the annual off take of sheep is estimated to be 33% (EAP, 2002), with an average carcass weight of 10 kg, which is the second lowest among sub Saharan Africa countries (FAO, 2004). However, these trends of events can be changed if animals are strategically supplemented with available protein and energy sources such as agro industrial by products or multi-purpose trees (MPT). Nevertheless, the use of agro industrial by products is limited to the area where they are produced or economic factors limit their wider use.

This calls for searching for alternative feed resources which could be used as supplement to improve animal performance. Multi-purpose trees are among the alternatives to be employed since it is abundant in different agro-ecological set up and contains higher nutrients. One potential source in the study area, in this regard, is the leaf and fruit of F .sycomorus. F. sycomorus is MPT and belongs to the family of Moraceae which is native to Ethiopia (Orwa *et al.,* 2009). It is available in Amhara National Regional State. F. sycomorus has been identified as feed of cattle, goat and sheep (Teferi *et al.*, 2008). F. sycomorus leaf are valuable fodder in overstocked semi-arid areas where the trees occur naturally and leaf are much-sought fodder with fairly high nutritive value of about 14-17.95% crude protein (CP) and 12 MJ/kg net energy on DM basis (Nkafamiya (2010; Devendra, 1990).

F.sycomorus leaf and petioles are well accepted by West African Dwarf lambs and led to higher levels of apparent digestibility than the other tree species (Anugwa and Okori, 1987). Feeding Ficus fodder to lambs is actively encouraged in Nigeria. Fruit of the plant are round from 2.8-5 cm in diameter conspicuous opening that may break at the one end and with various colours. Makishima (2005) found that F. sycomorus is the most abundant fruit supplier for frugivorous animals in the riverine forest in the semi arid northern Kenya. It is known that chimpanzees use Ficus species fallback sources of feed during the period of fruit scarcity (Fruichi *et al.*, 2001). Ficus fruit are available all the year round in Africa fruiting 3-5 times per year (Kinnaird, 1992).

In Sekela District, where this study was conducted, sheep feed on natural pasture, fallow land grazing and crop residues; where the nutrients supplied by these feed resources are insufficient to meet for maintenance, growth and production requirements of animals. Sometimes farmers in the area purchase protein supplements such as cotton seed meal and low quality roughage during dry season, but it is not effectively utilized. Moreover, the animals feed on fallen leaf and fruit of F. sycomorus since the tree grows around farm land residence and on the degrading area. In fact the leaf and fruit of tree are important sources of nutrient for small ruminants in the dry season. However, systematic evaluation of the value of F. sycomorus leaf and fruit for sheep has not been well researched in the study area. The current study was, therefore, designed to evaluate effects of supplementation with F. sycomorus leaf, fruit and their mixtures on performances of Washera sheep fed natural pasture hay and to assess the economic benefit of the effect of supplementation with F.sycomorus.

MATERIALS AND METHODS

Study Site

This study was conducted in Sekela Woreda in West Gojjam Administrative Zone, North-Western Ethiopia. The site is located at 466 km North West of Addis Ababa and situated at an altitude ranging from 2013 and 3257meter at sea level. The average annual rainfall of the area was 1738 mm with a bi-modal distribution from February to April and from June to September. The average annual minimum and maximum temperature was 8 and 21°C, respectively (Worldclim, 2009). Sekela has undulating landscape with degraded farmlands. Mixed crop- livestock production was the typical farming system in the Woreda with tree growing (Eucalyptus) as a common practice around farmlands and homesteads. Animal production in the Woreda is vital for the security and survival of large numbers of people. According to Sekela Agricultural and Rural Development Office (SARDO, 2009); the average land holding per household is 0.75 hectare.

Feed Preparation

Leaf of F. sycomorus was harvested by climbing the tree and pruning the branch of tree at the end of the rainy season from communal lands, local farmer's farm yard, and river banks around Gish Abay. The time of harvesting was determined based on the intensity of sunlight that facilitates drying and optimum growth of leaf with which biomass becomes higher. F. sycomorus fruit were also picked from the local tree fruit around Gish Abay. The Collection of fruits was done under the tree plant after the tree fruit ripened (red color). Fruit were fallen by the help of man. The leaf and fruit were air-dried under shade. F. sycomorus leaf's petiole was removed (twigs separating after lopping). The dried leaf was partially crushed and fruit were collected and put into sacks and stored in a well ventilated shade until used at room temperature. Adequate supplies of the experimental feeds were stored for use during the whole study period. The basal feed was natural pasture hay which was purchased from the surrounding farmers. After harvesting the hay was transported to the study sites, stored under shade to maintain its quality and used as a basal diet throughout the experimental period. Hay was manually chopped to the size of about 1-6 cm to minimize selective feeding by the sheep.

Animals and Management

Twenty yearling intact male Washera sheep were purchased from local market of Gish Abay. The animals were quarantined for a period of 21 days. During this period, all sheep were ear tagged for identification purpose, sprayed with acaricides (diazzinole) for external parasites and injections of Ivermectin solution for internal parasite and were vaccinated against common infectious diseases in the area such as pasteurellosis, anthrax and sheep pox based on the prescription of the veterinarian. Initial body weights of the animals was taken on two consecutive weighing after overnight fasting at the beginning of the acclimatization period (17.5$\pm$ 0.39; Mean$\pm$SD), and animals were grouped into five blocks of four animals each based on their initial BW. Sheep were adapted to the experimental feeds for additional

two weeks before commencement of the actual experiment. Experimental sheep were penned individually; the pen equipped with bucket and feed bins which was made from bamboo. Cleaning of pens was done daily before offering the day's feed.
Measured quantities of natural pasture hay were offered for ad libitum consumption allowing 25% refusal. Adjustment of feed offer was made every week. Supplemented sheep were offered supplements twice a day at 08:00 h, and 16:00 h in equal portions. The animals had available free choices to salt block and water during the whole day**.** The leaf and fruit were offered with plastic sheet which was tied to a bamboo stick over the cage and above the feed bins to collect fruit and leaf that may have fallen down and hay were offered with locally available bamboo feed bins.

Experimental Design and Treatments

The Experimental Design used in this experiment was completely randomized block design. Initial weights of the animals were determined by taking the mean of two consecutive weighing after overnight fasting. Based on the design, sheep were blocked into five groups based on initial body weight and treatments were randomly assigned to five animals per treatment. Dietary treatments were randomly assigned to one of the four treatment diets within a block. Treatments were comprised of feeding natural pasture hay ad libitum (un-supplemented: T_1) or natural pasture hay supplementation with either F. sycomorus leaf (Treatment 2: T2), or F. sycomorus fruit (Treatment 4; T4), or mixture of F. sycomorus leaf and fruit in a ratio of 1:1(Treatment3; T3). The amount of supplements offered was 300 g/day on DM basis.

Feeding Trial

Feeding trial was conducted for 90 days. Daily feed offered to the experimental sheep and the corresponding refusals was recorded and measured during the experimentation period to determine daily feed intake. Representative samples of feed offer per batch, and refusal per animal were collected and stored based on type of feed, pooled over the experimental period and sub-sampled for chemical analysis. Daily feed intake of individual sheep was calculated as the difference between the amounts of feed offered and refused. Substitution rate was calculated as the difference between basal diet intake of the un-supplemented and supplemented treatments divided by the amount of supplement offered (Ponnampalam *et al.,* 2004).

Body Weight Measurements

To determine the weight change of animals in the course of the experiment, live weight of each sheep was taken at every ten days intervals after overnight fasting and in the morning before provision of feed and water. Body weight was measured by using suspended salter scale. Body weight changes were determined as a difference between the final and initial body weight. Average daily body weight gain was calculated as the difference between final body weight and initial body weight of the sheep divided by the number of feeding days. Feed conversion efficiency was calculated by dividing the average daily body weight gain to average daily feed intake.

Chemical Analysis

Representative (composite) samples of feed offer and refusal samples collected during the feed trial were milled to pass through a 1mm sieve screen size and analyzed for DM and ash following the procedure of AOAC (1990). Acid detergent fiber (ADF), NDF and ADL components of each ingredient were determined according to the procedures of Van Soest and Robertson (1985). The crude protein was estimated by multiplying N with a nitrogen factor of 6.25.

Partial Budget Analysis

Partial budget analysis was carried out to determine profitability of the current supplementation strategy using Washera sheep. The analysis considered purchase and sale price of the sheep and cost of feed consumed during the experimental period. Market prices of the sheep were assessed in Gish Abay, Sureba Michael Maksegnt and Awi zone local markets and the value of live animals was estimated by person who was involved in sheep trading. Thus the average estimated price of sheep ranged from 265 to 440 ETB. Using the procedure of Upton (1979) net income (NI) would be calculated as the amount of money left when total variable costs (TVC) were subtracted from the total returns (TR).

NI= TR-TVC

The change in net income (ΔNI) was calculated as the difference between change in total return (ΔTR) and the change in total variable costs (ΔTVC).

ΔNI = ΔTR-ΔTVC.

The marginal rate of return (MRR) measures the increases in net income (ΔNI) associated with each additional unit of expenditure (ΔTVC).

MRR= ΔNI / ΔTVC

Statistical Analysis

Feed intake, digestibility, body weight gain and carcass parameters were subjected to analysis of variance (ANOVA) using the general linear model procedure in SAS soft ware (V9) (SAS, 2002). The association between nutrient intake, digestibility and body weight gain was tested using correlation analysis. Treatment means were separated using least significant difference (LSD). The model employed was:

$$\mathbf{Y_{ij} = \mu + t_i + b_j + e_{ij}},$$

Where; Y_{ij} = Response variable
μ = Overall mean
t_i = Treatment effect
b_j = Block effect (initial body weight)
e_{ij} = Random error

RESULTS

Chemical Composition of the Experimental Feeds

The chemical composition of feedstuff used in this study is given in Table 1 below. In the current experiment the CP content of F.sycomorus leaf was 17.9%. The NDF, ADF, ADL, DM and ash content of F. sycomorus leaf on DM basis in this study was 64.6%, 52.5%, 17.4%, 93.2% and 11.9%, respectively. On the other hand, the CP content of the F.sycomorus fruit in the current study was 11.8%. The hay offered to the experimental animals in the current study had CP content of 7.9% with higher NDF and ADF composition.

Feed Intake

The mean daily intakes of DM, OM, CP, NDF and ADF of Washera sheep fed a basal diet of natural pasture hay and supplemented with F. sycomorus leaf, fruit and their mixtures are presented in Table 2. The basal feed DM intake was higher (P>0.05) for sheep fed on T1 diet as compared to sheep in supplemented group (T2-T4).

Table 1. Chemical composition of feedstuff

Feed type	DM	Ash	OM	CP	NDF	ADF	ADL
Feed offer							
		%DM					
Hay	93.2	8.4	92.6	8.0	73.1	54.6	16.3
FSL	93.2	11.9	88.2	17.9	64.6	52.5	17.4
FSF	92.3	5.7	94.3	11.8	35.2	32.7	14.4
1FSL:1FSF	92.7	8.8	91.3	14.9	49.9	42.6	15.9
Refusal							
Hay (T1)	93.4	10.8	89.2	3.8	80.0	59. 2	16.8
Hay (T2)	93.5	9.3	90.7	4.8	81.3	55.9	16.3
Hay (T3)	93.4	8.9	91.1	5.1	78.7	58.3	17.8
Hay (T4)	93.5	8.7	91.3	4.8	81.4	60.0	17.3

ADF = acid detergent fiber; ADL =acid-detergent lignin; CP =crude protein; DM = dry matter; FSL= F. sycomorus Leaf; NDF= neutral detergent fiber; OM =organic matter; FSF=F. sycomorus Fruit.

Among supplemented group, sheep in T2 had higher (p<0.05) dry matter intake from the basal diet followed by sheep in T3 and T4. In spite of the fact that supplemented group received equal quantity of the supplements (300 g/day), the lower basal DM intake recorded for sheep in T4 followed by T3 as compared to sheep in T2 might be explained by differences in nitrogen content of the different supplements. The total DM intake was higher (P<0.001) in the order T2>T3>T4 which could be attributed to differences in crude protein composition of the different types of supplements.

Table 2. Daily dry mater intake of Washera sheep fed natural pasture hay alone and supplemented with F.sycomorus leaf, fruit and their mixtures

DM intake (g/day)	Treatments				SEM	Pr>F
	T_1	T_2	T_3	T_4		
• Basal	581.7^a	429.9^b	402.6^c	375.4^d	3.85	<.0001
• Supplement	-	300.0	300.0	300.0	-	-
• Total DMI	581.7^d	729.9^a	702.8^b	675.4^c	13.18	<.0001
DMI as %BW (%)	3.0^b	3.7^a	3.6^a	3.5^a	0.07	0.0387
DMI as MBW($g/kg^{0.75}$) $Kg^{0.75}$($BW^{0.75}$)	66.0^d	73.4^a	71.9^b	69.5^c	0.36	0.001
Total CPI	45.7^d	85.8^a	79.2^b	72.7^c	3.51	<.0001
Total OMI	538.7^d	662.7^a	646.8^b	631.3^c	11.19	<.0001
Total NDFI	360.1^d	484.8^a	422.4^b	393.9^c	2. 58	<.0001
Total ADFI	303.2^d	392.0^a	347.6^b	317.5^c	7.87	<.0001
Total ADLI	101.5^d	122.2^a	113.3^b	104.5^c	1.89	<.0001
ME (MJ /kg DM)	4.9^c	8.0^a	7.7^{ab}	7.4^b	0.29	<.0001
Substitution rate	-	0.51^c	0.60^b	0.69^a	0.016	<.001

[a-d]means with different superscripts in row are significantly different; ADF=Acid detergent fiber; ADL= Acid detergent lignin; CP = crude protein; DM= dry matter; ME = metabolisable energy; FSL = F. sycomorus Leaf; NDF = neutral detergent fiber; OM = organic matter; SEM= standard error of mean; FSF = F. sycomorus Fruit ; T_1= natural pasture hay alone; T_2 = hay +300 g FSL DM; T_3 = hay +300 g 1FSL:1FSF DM mix; T_4 = hay +300 g FSF on DM basis.

The total average daily CP intake was significantly lower (P<0.001) in un-supplemented group than supplemented sheep. This could be attributed to the relatively low CP content of the basal feed. The CP, OM, NDF and ADF intakes in the current study were significantly higher (P<0.001) for sheep in the supplemented group (T_2-T_4) than in the un-supplemented (T_1). This could be due to improved rumen condition created by the supplementation that enhanced feed intake. There was also significantly higher (P<0.001) estimated metabolizable energy intake (EME**)** for supplemented group as compared to sheep in the un-supplemented. The total DM intake as a percent of body weight was also higher for sheep in supplemented group as compared to the un-supplemented.

Among the supplements, sheep in T_2 had higher DMI expressed as percent of body weight followed by sheep in T_3 and T_4. The rate of substitution was higher in the present experiment and the difference among dietary treatments is significant (P<0.001).

Trends in total dry matter intake of Washera sheep fed natural pasture hay alone and supplemented with F. sycomorus leaf, fruit and their mixtures is presented in Figure 1.
DM = dry matter; FSL = F. sycomorus Leaf; FSF= F. sycomorus Fruit; T_1 (un-supplemented) = natural pasture hay; T_2 = hay +300g FSL; T_3 = hay + 300 g 1FSL:1FSF DM mix; T_4 = hay +300 g FSF DM.

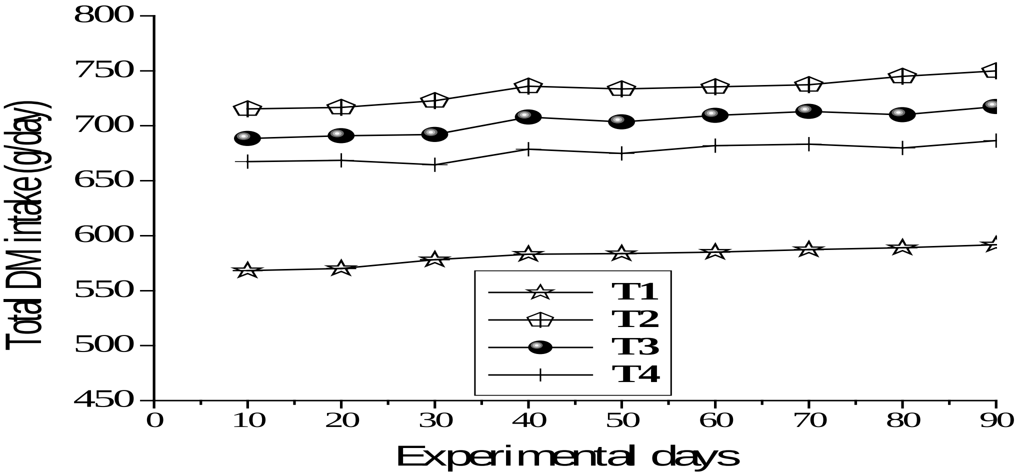

Figure 1. Trends in dry matter intake across the experimental period for Washera sheep fed natural pasture hay alone and supplemented with F. sycomorus leaf, fruit and their mixtures.
It is apparent from the figure that total feed dry matter intake increased as feeding period advanced. However, sheep in the un-supplemented group maintained lower feeding intake throughout the study period compared to supplemented animals.

Body Weight Change and Feed Conversion Efficiency

Mean initial and final body weight (FBW), average daily body weight gain (ADG) and feed conversion efficiency (FCE) of Washera sheep fed on grass hay and supplemented with F. sycomorus leaf, fruit and their mixtures are presented in Table 3 below. Supplementation significantly improved (P<0.001) daily BW gain compared to the un-supplemented. However, among the supplemented group, sheep in T2 performed significantly better (P<0.05) than sheep in T3 and T4. Supplementation also significantly increased (P<0.001) FCE and FBW of sheep compared to the un-supplemented treatment.

The lower FCE for T1 was probably because of the relatively low CP and energy intake and higher fiber content of the basal diet that might have caused the use of metabolizable energy to be depressed slightly.

Table 3. Body weight parameters, feed conversion efficiency of Washera sheep fed natural pasture hay alone and supplemented with F. sycomorus leaf, fruit and their mixtures

Parameters	T_1	T_2	T_3	T_4	SEM	Pr>F
Initial body weight (kg)	17.5	17.5	17.6	17.5	0.08	0.5888
Average daily gain (g/day)	8.0^c	45.1^a	36.9^b	36.2^b	3.41	0.0053
Final body weight (kg)	18.2^c	21.6^a	20.9^b	20.8^b	0.32	0.0058
Body weight change (kg)	0.72^c	4.1^a	3.3^b	3.3^b	0.31	<.0001
FCE (g ADG/g DMI)	0.01^d	0.06^a	0.05^b	0.05^c	0.004	<.0001

$^{a-c}$ Means with different superscripts in the same row differ significantly; DMI = dry matter intake; FCE = feed conversion efficiency; HCW = hot carcass weight; FSL = F. sycomorus Leaf; SEM = standard error of mean; FSF = F. sycomorus Fruit; T_1 = natural pasture hay; T_2 = hay + 300 g FSL DM; T_3 = hay + 300 g 1FSL:1FSF DM mix; T_4 = hay + 300 g FSF DM.

Trends in body weight change of Washera sheep fed natural pasture hay alone or supplemented with F. sycomorus leaf, fruit or their mixtures is presented in Figure 2.
FSL= F. sycomorus Leaf; FSF= F. sycomorus Fruit; T1=natural pasture hay; T2 = hay + 300g 1FSL DM; T3 = hay + 300 g 1FSL:1 FSF DM mix; T4 = hay +300g FSF DM.

It was made clear from the figure that as the feeding period advanced, body weight change of experimental animal varied. Thus, animals in the un-supplemented maintained their body weight. However, animals in the supplemented group (T_2-T_4) showed an increasing trend across the feeding period.

The relationship between average daily gain (dependent variable) and CP intake (independent variable) was assessed using simple linear regression analysis as presented in Figure 2. Thus, the fitted regression model explained 95% of the total variation (R^2=0.951). The result showed that for each unit change in CPI, ADG changes by 0.903.

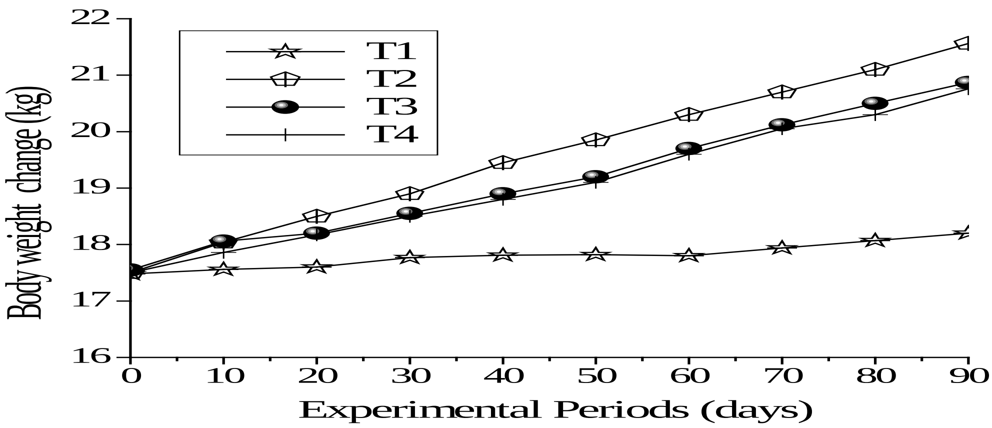

Figure 2. Trends in body weight change across the feeding period for Washera sheep fed natural pasture hay alone and natural hay supplemented with F. sycomorus leaf, fruit and their mixtures.

Partial Budget Analysis

Partial budget analysis was conducted to assess the economic benefit of supplementation with F. sycomorus leaf, fruit and their mixture feed to Washera sheep under stall feeding system Table 8 below. According to partial budget analysis, sheep supplemented with dried leaf of F. sycomorus (T_2) followed by the mixtures of its leaf and fruit (T_3) returned a higher profit margin than sheep supplemented with fruits of F. sycomorus (T_4) and the un-supplemented (T_1).

The present result suggested that supplemented with F. sycomorus leaf (T_2) and its mixture with fruit (T_3) is potentially more profitable than supplemented with fruit of F. sycomorus (T_4) or the un-supplemented (T_1). The finding was attributed to the higher ADG and final body weight recorded for sheep in T_2 and T_3. Sheep supplemented with T_3 had statistically equivalent body weight gain compared to sheep supplemented with T_4.

However, it had higher estimated selling price but lesser net income and very low change in net income. Therefore, the net return of T_2 (198.2ETB) was higher than T_3 (137.5ETB) and T_4 (127.7ETB). The difference in the net return among treatments could be attributed mainly to feed conversion efficiency.

Table 4. Partial budget analysis of Washera sheep fed natural pasture hay alone and supplemented with F. sycomorus leaf, fruit and their mixtures

Variables	Treatments			
	T_1	T_2	T_3	T_4
Purchasing price of sheep (ETB/head)	212.0	212.0	212.0	212.0
Estimated selling price of sheep (ETB/head)	265.0	440.0	380.0	375.5
Total hay consumed (kg/head)	59.0	45.5	40.3	36.9
Total leaf of F. sycomorus consumed (kg/head)	-	28.9	0.0	0.0
Total Fruit of F. sycomorus consumed (kg/head)	-	0.0	0.0	28.6
Total Fruit and leaf of F. sycomorus consumed (kg/head)	0.0	0.0	28.2	0.0
Cost for hay (ETB/sheep)	23.6	18.2	16.1	17.2
Cost for leaf of F. sycomorus (ETB/sheep)	0.0	11.6	0.0	0.0
Cost for fruit of F. sycomorus (ETB/sheep)	0.0	0.0	0.0	18.6
Cost for fruit and leaf of F. sycomorus (ETB/sheep)	0.0	0.0	14.1	0.0
Total feed cost /VC (ETB)	23.6	29.8	30.5	35.8
TRR	53.0	228.0	168.0	163.5
NI(ETB)	39.4	198.2	137.5	127.7
∆N	0.0	145.2	-60.7	-9.8
∆TVC	0.0	6.2	0.7	5.3
MRR	0.0	23.4	8.7	1.9

▲NI= change in net income; ETB= Ethiopian Birr; FSL=F. sycomorus Leaf MRR= marginal rate of return; NI= Net income; Suppl. = supplement; FSF= F. sycomorus Fruit; TR= total return; TVC= total variable cost; T_1= natural pasture hay; T_2= T_1+ 300g leaf; T_3= T_1+150g leaf: 150g fruit mix; T_4= T_1 + 300 g fruit. NB=Feed stuff Cost used to conduct the experiment were natural pasture hay, F.sycomorus leaf and F.sycomorus fruit 40 ETB /Qt,40 ETB / Qt, 70 ETB/Qt respectively and .the partial budget of the experiment was done by considering the labor cost as the price of F. sycomorus tree leaf and fruit. ETB = Ethiopian birr Qt = Quintile

The present result suggested that supplemented with F. sycomorus leaf (T_2) and its mixture with fruit (T_3) is potentially more profitable than supplemented with fruit of F. sycomorus (T_4) or the un-supplemented (T_1). The finding was attributed to the higher ADG and final body weight recorded for sheep in T_2 and T_3. Sheep supplemented with T_3 had statistically equivalent body weight gain compared to sheep supplemented with T_4. However, it had higher estimated selling price but lesser net income and very low change in net income. Therefore, the net return of T_2 (198.2ETB) was higher than T_3 (137.5ETB) and T_4 (127.7ETB). The difference in the net return among treatments could be attributed mainly to feed conversion efficiency.

DISCUSSIONS

Chemical Composition of the Experimental Feeds

The chemical composition of feedstuff used in this study is given in Table 1 below. In the current experiment the CP content of F. sycomorus leaf was 17.9%. Similar result (17.95%) was also reported by Nkafamiya *et al.* (2010). On other hand, Njidda and Ikhimioya (2010) and Lorenzo (2002) reported 14.9 and 22.1% CP for F. sycomorus leaf, respectively. The NDF, ADF, ADL, DM and ash content of F. sycomorus leaf on DM basis in this study was 64.6%, 52.5%, 17.4%, 93.2% and 11.9%, respectively. The results for NDF and ADF composition were higher than 54.8% and 33.4% reported by Njidda and Ikhimioya (2010). However, literature is inconsistent with regard to the CP composition of F. sycomorus leaf. Nkafamiya *et al.* (2010) reported 17.95%. The DM content of F. sycomorus leaf documented in this study was lower than 95.6% reported by Njidda and Ikhimioya (2010) but higher than 85.9% reported by Nkafamiya *et al.* (2010). The ash content of F. sycomorus leaf in the current study is higher than 9.5% reported by Nkafamiya *et al.* (2010) but lower than 18% reported by Njidda and Ikhimioya (2010). Moreover, the ash composition of the leaf of F. sycomorus was higher than fruit of the same plant and natural pasture hay.

On the other hand, the CP content of the F. sycomorus fruit in the current study was higher than 6.9-9.5% reported by Makishima (2005) and Lorenzo (2002). The difference in chemical constituents between the present findings and literature might be attributed to differences in harvesting season, stage of harvesting, growth pattern of the species within the genus, genetic potential, bioclimatic conditions and cropping systems as reported by Chanda and Bhaid (1987) and Divakaran *et al.* (1985).

The hay offered to the experimental animals in the current study had CP content of 7.9% with higher NDF and ADF composition. Even though the CP content of hay recorded in the present study was higher than 4.2% and 3.7% reported by Mulu *et al.* (2008) and Asnakew (2005), respectively; and lower than 10.9% reported by Yihalem (2004), it was expected to meet maintenance requirement of the animals. Therefore, the hay used in the current study was characterized as good quality hay in terms of CP content. It has been stated that CP value ranging from 7-7.5% is required to satisfy the maintenance need of ruminants (Van Soest, 1982).

Feed Intake

The basal feed DM intake was higher ($P>0.05$) for sheep fed on T_1 diet as compared to sheep in supplemented group (T_2-T_4). Among supplemented group, sheep in T_2 had higher ($p<0.05$) dry matter intake from the basal diet followed by sheep in T_3 and T_4. In spite of the fact that supplemented group received equal quantity of the supplements (300 g/day), the lower basal DM intake recorded for sheep in T_4 followed by T_3 as compared to sheep in T_2 might be explained by differences in nitrogen content of the different supplements. Consequently, this had negatively impacted total dry matter intake. Topps (1997) reported that supplementation level beyond 30-40% of the total DM offered reduces intake of the basal feed.

The total DM intake was higher ($P<0.001$) in the order $T_2>T_3>T_4$ which could be attributed to differences in crude protein composition of the different types of supplements. The supplemented sheep consumed higher total DM because supplementation might have created a favorable rumen environment resulting in enhanced fermentation of the basal roughage and thus increased microbial protein synthesis (Osuji *et al.*, 1995). The positive effects of supplementation on feed intake may have been a reflection of the increase in the intake of essential nutrients such as energy, vitamins and minerals and in particular nitrogen. Moreover, the high total DM intake in supplemented group could be due to lower gut fill of the supplements compared to natural pasture hay. The increase in total DM intake due to supplementation in the present study was in agreement with the result reported by Hirut (2008) and Wondwosen (2008).The total average daily CP intake was significantly lower ($P<0.001$) in un-supplemented group than supplemented sheep. This could be attributed to the relatively low CP content of the basal feed. However, the CP content of the basal diet was slightly higher than maintenance requirement of small ruminants (Minson, 1990; Gatenby, 2002).

The CP, OM, NDF and ADF intakes in the current study were significantly higher ($P<0.001$) for sheep in the supplemented group (T_2-T_4) than in the un-supplemented (T_1). This could be due to improved rumen condition created by the supplementation that enhanced feed intake. Adugna and Sundstol (2000) also reported that the increased intake in the supplemented group could be due to increased availability of nitrogen to rumen microbes and enhanced rate of digestion. Among supplemented group, however, it was higher for sheep in T_2 followed by T_3 and T_4. The higher CP contained in F. sycomorus leaf (17.9%) as compared to F. sycomorus fruit (11.8%) might have rendered sheep in T_2 followed by T_3 to have higher intakes. According to Kempton *et al.* (1979) and Dothi (2001), dietary protein supplementation is known to improve intake by increasing the supply of N to the rumen microbes or can be increased by reducing poor quality feed retention time after supplementing concentrates to micro-organisms and stimulating their function in the rumen. There was also significantly higher ($P<0.001$) estimated metabolizable energy intake (EME**)** for supplemented group as compared to sheep in the un-supplemented. The intake of energy increased in the order of T_2 >T_3>T_4 with increased level of F. sycomorus leaf as suggested previously (Montaldo, 1972).

The total DM intake as a percent of body weight was also higher for sheep in supplemented group as compared to the un-supplemented. Among the supplements, sheep in T_2 had higher DMI expressed as percent of body weight followed by sheep in T_3 and T_4. The results obtained in the current study were not very different from those reported for various breeds of sheep and goats in the tropics (Devendra and Burns, 1983).

The rate of substitution was higher in the present experiment and the difference among dietary treatments is significant (P<0.001). Substitution rates are often low when animals consume forage of low to medium digestibility. Doyle *et al.* (1988) suggested that the rate at which basal hay intake reduce with increasing supplement intake (the substitution rate) reflects directly the effect of the supplement on the fractional rates of digestion and outflow from the rumen. Those supplement feeds with rapid fermentation rate replace the basal roughage to a lower extent than those that ferment slowly (Nsahalai and Ummuna, 1996).

Body Weight Change and Feed Conversion Efficiency

Supplementation significantly improved (P<0.001) daily BW gain compared to the un-supplemented. However, among the supplemented group, sheep in T2 performed significantly better (P<0.05) than sheep in T3 and T4. Supplementation also significantly increased (P<0.001) FCE and FBW of sheep compared to the un-supplemented treatment. The lower FCE for T1 was probably because of the relatively low CP and energy intake and higher fiber content of the basal diet that might have caused the use of metabolizable energy to be depressed slightly. Adebowale *et al.* (1991) also reported that the low degree of digestion coupled with low passage rate through the alimentary tract limit net energy availability for production. However, supplemented sheep (T2-T4) did significantly (P>0.01) differ in these parameters.

Supplementation of MPT to small ruminants improved growth performance as documented earlier (Melaku *et al.*, 2004; Reed *et al.*, 1990). Similarly, Aynalem and Taye (2008) reported average daily gain of 43.3, 50.5 and 95.1 g/day in lambs supplemented with 200, 300 and 400 g/day Girawa, respectively. It has been reported that fodder trees would be good protein supplements for ruminants, provided that they are degraded adequately in the rumen to make the protein available to the animal and non-toxic (Leng, 1997). Anugwa and Okori (1987) reported that, West African dwarf lambs gained 71 g/day over a 14-day period when fed a sole diet of F. elasticoides foliage. However, the F. sycomorus leaf, fruit and their mixture in the current study could change the body weight gain, possibly sufficient supply of protein.

Generally, supplementation with MPTs like F. sycomorus leaf, fruit and their mixture appeared to improve daily BW gain of sheep, probably either by providing nutrient available for absorption or by enhancing microbial protein synthesis. Though there has not been exhaustive study conducted on F. sycomorus in Ethiopia on one hand and Washera sheep on the other, the average daily gain recorded in the present study was small compared to literature. This might be attributed to the alkaloid concentration of F. sycomorus and/or size of the sheep breed used for the study. Similarly, in this study, sheep fed natural pasture hay alone exhibited mean BW gain of 8 g/day. This positive ADG indicates that natural pasture hay used in the current experiment provided nutrients sufficient for maintenance requirements of the animals.

CONCLUSION

This experiment verified that supplementing intact male yearling Washera sheep with natural pasture hay alone (T_1) or natural pasture hay supplemented with either leaf (T_2), mixture of leaf and fruit (at a ratio of 1:1; T_3) or fruit (T_4) of F .sycomorus improved average daily body weight gain, empty body weight and hot carcass weight supplemented compared with un-supplemented (T1). In general, supplementation with 300g FSL, FSF and their mixture (FSL: FSL) improved the performance of sheep compared to the un-supplemented. Among the feeding strategy employed, supplementing sheep with T_2 becomes biologically optimum and economically feasible.

RECOMMENDATIONS

Due to shortage of pasture/grazing land, high cost of agro industrial by products and increasing competition with other livestock, it is economical and biologically advantageous to use F. sycomorus leaf and its fruits as supplement to improve productivity of sheep. Since supplementation with F. sycomorus leaf resulted in the highest performance parameters in sheep and returned the highest income, small holder farmers are advised to supplement sheep with leaf in order to exploit the genetic potential of the animals.

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