Effect of Atella, Birint and their Mixture Supplementation on Feed Intake, Digestibility and Body Weight Change of Washera Sheep Fed Oat (Avena sativa) Straw Basal Diet, in Machackel District East Gojjam Zone

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Twenty yearling intact male Washera sheep with an average initial body weight of 19.1 ± 1.7 kg (mean ± SD) were used to determine the nutritional value of local brewery by products on sheep performance. The experimental design was Randomized Complete Block Design and animals were blocked into five blocks of four animals based on their initial body weight. Dietary treatments were oat straw alone (T1), oat straw + Atella (T2), oat straw + Birint (T3), oat straw + mixture of 50% Atella and 50% Birint. The supplements were offered at the rate of 400 g/day on the Dry Matter basis with no left over. A total of ninety days feeding trial and seven days of digestibility trial was conducted. The crude protein content of oat straw, Noug Seed Cake, Atella, Birint and their mixture was 4.84%, 28%, 21.5%, 23.4% and 22.7%, respectively. Sheep in T1 consumed lower total Dry matter but greater (p<0.001) basal diet (oat straw) as compared to the supplemented groups. Crude protein intake ranged 33.51 to 123.89 g/day and was lowest for T1 and higher for the supplemented groups. Digestibility of Dry Matter, Organic Matter, Crude protein, and Neutral Detergent Fiber was increased due to supplementation. Average Daily Gain was -0.88, 53.33, 70 and 58.44 g/day for T1, T2, T3 and T4, respectively. Feed conversion efficiency ranged 0.009 to 0.09g ADG/g DMI and took a similar trend like that of ADG.

Key words: Atella, Birint, oat straw, Washera sheep, body weight, digestibility

INTRODUCTION

Ruminant animals in Ethiopia receive most of their dietary feeds from native pastures and crop residues. However, natural pastures and crop residues are usually fibrous, poor in digestibility, and devoid of most essential nutrients including proteins, energy, minerals, and vitamins (Yoseph et al., 2003). The nutritive value of crop residue can be improved through supplementation with conventional feed resources (McDonald et al., 2002). However, the strategy of supplementing crop residues with conventional feed resources is both in short supply and expensive (Anderson, 1987). In addition to these, conventional feed resources are mostly concentrated in urban areas and hence their availability is very limited to rural farmers. Therefore, to avoid this problem, there is a need to look for some alternatives but locally available and cheap sources of protein. Due to their low cost and availability, non-conventional feed resources such as local brewery by-products were widely used by smallholder farmers (Yoseph et al., 2003).

Non-conventional feeds are feeds that have not been traditionally used in animal feeding and or are not normally used in commercially produced rations for livestock (Nitis, 1999). Non-conventional feeds could partly fill the gap in the feed supply, decrease competition for food between humans and animals, reduce feed cost and contribute to self-sufficiency in nutrients from locally available feed sources. Two of the locally available non-conventional feeds are Atella and Birint.

Atella and Birint can be a good protein and energy source when included in animal ration although, the nutrient content showed variation due to differences in the ingredients used for preparation and methods of preparation followed in different areas. Atella and Birint are highly produced in Machackel district, however information

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on the effects of supplementation with *Atella* alone or in combination with *Birint* for sheep fed oat straw basal diet is generally inadequate.

Therefore, the current study was designed with the general objective of evaluating the feeding value of *Atella*, *Birint* and their mixture to Washera sheep fed oat straw basal diet.

**MATERIALS AND METHODS**

**Description of the Study Area**

The study was conducted in Machackel District, particularly in Yedefas Kebele, East Gojjam zone, Amhara National Regional State located at a distance of 316 Km from Addis Ababa and 236 Km from Bahir Dar, the capitals of Ethiopia and Amhara National Regional state, respectively. The site is located at an altitude of 2,446 m above sea level, with a geographical location of 10° 40’ 0” North latitude and 37° 20’ 0”East Longitude (MWAO, 2017/18). The annual rainfalls of the district range from 1500 mm to 1800 mm. The mean annual temperature is 17.5°C with the area receiving rainfall from May to mid-September, the remaining months being the dry seasons.

Major livestock feed resources in the district are natural pasture, crop residues, local brewery by- product (*Atella* and *Birint*), agro-industrial by-products and others (MWAO, 2017/18). Animals largely depend on natural grazing especially in the rainy season and crop residues late in the dry season. Major crops grown in the district are wheat, teff, Maize, Barely, Bean, Noug (*Guizotia abyssinica*) and Oat (*Avena sativa*). The district has a total population of 133,138 of which 62,177 male and 66,017 are females. The district has a livestock population of 91,343 cattle, 47, 222 sheep, 5, 215 goats, 15,608 equines, 61,431 chicken and 9,883 bee colonies (MWAO, 2017/18).

**Experimental Animals and Management**

Twenty yearling intact male growing sheep with initial body weight of 19.1 ± 1.7 kg (mean ± SD) were purchased from market of Quarit district, the place where relatively pure Washera sheep breeds are found. The age of sheep was determined by dentition and information obtained from the owners. Animals were quarantined for 21 days to observe them for their health status. During this time, they were dewormed for internal parasites using albendazol and fasinex and sprayed for external parasites using diazinon. Experimental animals were also vaccinated against common diseases of the area like pasteurellosis and anthrax based on recommendation of a veterinarian. They were accustomed to the experimental diets for 15 days before the commencement of the actual experiment. Each sheep was identified with neck collars. After the quarantine period, animals were kept in individual pens and feed was offered to them. Each pen was equipped with feeding and watering troughs. Cleaning of the pen was done once a day early in the morning. For feeding of oat straw, bamboo basket was used while concentrate and water were offered in plastic buckets. The experimental sheep had free access to water and common salt licks. Sheep were closely observed for the occurrence of any ill health and disorders throughout the experimental period.

**Experimental Design and Dietary Treatments**

A randomized complete block design (RCBD) with four treatments consisting of five replication and four sheep in a block was used (Table 1). The experimental sheep were blocked based on their initial body weight (IBW), which was determined as a mean of two consecutive weighings after overnight fasting at the end of the quarantine period. Sheep within a block were assigned to one of the four dietary treatments randomly. The treatments consisted of oat straw fed *ad libitum* alone or supplemented with *Atella*, *Birint* and their mixture. Oat straw was provided to all animals *ad libitum*. All sheep was accessed to water and mineralized salt block. A fifty gram of noug seed cake was added for each animal to meet the maintenance requirement of the non-supplemented group, because oat straw has low CP value for which it does not fulfill the maintenance requirement.

**Table 1: Layout of experimental treatments**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sole oat straw <em>ad libitum</em> +50g NSC</td>
</tr>
<tr>
<td>2</td>
<td>oat straw <em>ad libitum</em> +400 g Atella +50g NSC</td>
</tr>
<tr>
<td>3</td>
<td>oat straw <em>ad libitum</em> +400 g Birint +50g NSC</td>
</tr>
<tr>
<td>4</td>
<td>oat straw <em>ad libitum</em> +200 g Atella +200 g Birint +50g NSC</td>
</tr>
</tbody>
</table>

NSC = noug seed cake

**Experimental Feed collection and Preparation**

*Atella* (by product of *Tella*) and Birint (by products of *katicala*) were collected from local brewery producers until the required amount is obtained. The collected wet *Atella* and *Birint* were spread on a plastic sheet to reduce the moisture content at the required level of (12-14%) and were stored in sacks properly. Samples were taken from each batch for chemical analysis. The basal diet (oat straw) was purchased from the local market (Amanuel) and stored under the shade. Straw was chopped manually to encourage the intake. All the estimated quantity of *Atella*, *Birint* and straw were stored in well ventilated room to avoid formation of mould and spoilage during the experimental period.

**Feeding Trial**

The feeding trial was continued for about 90 days. Oat straw, mineral licks and water were available to all sheep *ad libitum*. *Atella*, *Birint* and their mixture were offered
twice a day at 0800 and 1600 hours. Oat straw was provided to all animals *ad libitum* by adding a 20% allowance of the previous day’s intake. The amount of feed offered and refused were weighed and recorded for each sheep daily. DM and nutrient intakes were determined as a difference between amount offered and amount refused. Representative samples of feed offered were collected per batch. Refusal samples for each sheep were collected and pooled per treatment. Sub-samples of the feed offered and refusals were used for chemical analysis. The animals were weighed initially and every 15 days afterwards. Body weight was taken before the morning meal and after overnight fasting of the animals. The body weight of the sheep was measured using hanging balance and the feed offered and refused were measured using kitchen scale. The average daily body weight change was calculated by dividing differences of the Final Body Weight and Initial Body Weight by the number of feeding days. Feed conversion efficiency (FCE) of the experimental animal was calculated by dividing average daily gain (ADG) by daily total DM intake.

The substitution rate was calculated by the equation adapted from Ponnampalam *et al.* (2004) as given below:

\[
\text{Substitution rate} = \frac{\text{oat straw intake of control treatment} - \text{oat straw intake of the supplemented treatment}}{\text{Supplement intake}}
\]

**Digestibility Trial**

The digestibility trial was conducted following the feeding trial with the same animals from the feeding trial. All animals were harnessed with fecal collection bags for the determination of digestibility. The digestibility trial took a total of 10 days with three days of adaptation of carrying the fecal collection bags. After three days of adaptation, daily total fecal output along with the daily feed offered and refused were weighed and recorded for seven consecutive days for each animal. Total faces voided were collected and weighed morning before feeding and stored at a temperature of −20 °C. Out of the daily total fecal output, 20% was sub-sampled to form a weekly fecal composite sample for each animal. On the last day of the collection period, fecal samples were thawed, thoroughly mixed, sub-sampled, dried at 60 °C for 72 hours and ground to pass through a 1 mm sieve screen and stored in a plastic bag pending chemical analysis. Grabs of feed samples from each feed and refusals from each sheep were collected each day to make a weekly composite feed sample for each feed and refusal for each sheep. The refusal samples were then pooled per treatment. Thereafter subsamples from feeds and refusals were taken for chemical analysis, dried, ground as indicated above, and stored in a plastic bag pending chemical analysis. The apparent digestibility coefficient of DM and nutrients were calculated using the following formula.

\[
\text{Apparent DM digestibility} = \frac{\text{DM intake} - \text{DM excreted in the faeces}}{\text{DM intake}} \times 100
\]

**Chemical Analysis**

Samples of feeds, refusals, and faeces were analyzed for DM, ash and N contents according to the procedures described by AOAC (1990). The CP contents of feeds, refusals and feces were calculated as CP = N% * 6.25. Organic matter (OM) content was determined as 100 - ash. Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were determined following the procedure of Van Soest and Robertson (1985).

**Statistical Analysis**

The data obtained on feed intake, body weight change and feed conversion efficiency were subjected to analysis of variance (ANOVA) using the general linear model procedure of (SAS, 2002). Differences among treatment means was tested by using least significance difference (LSD). The model was:

\[
Y_{ij} = \mu + T_i + B_j + e_{ij}
\]

Where, \(Y_{ij}\) = observation in the \(i^{th}\) block and \(j^{th}\) treatment

\(\mu\) = overall mean

\(T_i\) = the \(i^{th}\) treatment effect

\(B_j\) = the effect of \(j^{th}\) block

\(e_{ij}\) = random error

**RESULTS AND DISCUSSION**

**Chemical Composition of Treatment Feeds**

The chemical composition of the experimental feeds used in the current study is indicated in Table 2. There was variation in chemical composition among the feeds used in the experiment. Higher CP value was recorded from *Birint* supplement while the minimum CP value was recorded from oat straw (basal diet). The CP content of *Atella* was lower than *Birint* and their mixture. Difference in the CP contents of *Atella* and *Birint* in the current study may be due to the variation in the ingredients used for *Tella* and *Katicala* preparation as well as fermentation process.

The chemical composition of oat straw used in the current study can be characterized by its low CP and high fiber contents than supplemental feeds (*Atella* and *Birint*). The NDF content of feed above 70% is considered as high roughage feed that limit the intake and digestibility (Alemu, 1981). In this case, the high NDF content of oat straw used in the current study may limit intake and digestibility of feed. Oat straw had also higher ADF contents which may limit the availability of nutrients contained in it, as feed that contain large proportion of ADF have low availability of nutrients and therefore ADF is negatively correlated with digestibility (McDonald *et al.*, 2002).
The crude protein (CP) value recorded for oat straw used in the current study was below the crude protein requirement of sheep (8%) for normal rumen microbial activity and for maintenance (NRC, 1985), and as such 50g of noug seed cake was added to fulfill the maintenance requirement of the sheep especially for the control treatment. Generally, feeds low in protein and high in fiber content results in low digestibility and voluntary feed intake (Adugna et al., 2002). Thus, the current study revealed the need for oat straw to be supplemented with high quality feeds for its efficient utilization.

Table 2: Chemical composition of treatment feeds

<table>
<thead>
<tr>
<th>Chemical composition</th>
<th>Treatment Feeds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OS</td>
</tr>
<tr>
<td>DM (g/kg)</td>
<td>950.0</td>
</tr>
<tr>
<td>Ash (k/kg DM)</td>
<td>72.7</td>
</tr>
<tr>
<td>OM (g/kg DM)</td>
<td>927.3</td>
</tr>
<tr>
<td>CP (g/kg DM)</td>
<td>48.4</td>
</tr>
<tr>
<td>NDF (g/kg DM)</td>
<td>786.5</td>
</tr>
<tr>
<td>ADF (g/kg DM)</td>
<td>659.6</td>
</tr>
<tr>
<td>ADL (g/kg DM)</td>
<td>244.6</td>
</tr>
</tbody>
</table>

ADF = acid detergent fiber; ADL = acid detergent lignin; CP = crude protein; DM = dry matter; NDF = neutral detergent fiber; OM = organic matter; ATL = Atella; BRT = Birint; OS = oat straw; NSC = noug seed cake.

The crude protein content of supplemental feed used in the current study is greater than 15%, a level usually required for growth performance (Norton, 1982). Among the supplemented treatments, Birint had higher CP value compared to Atella and their mixture. Based on the results obtained in the current study, Birint and Atella were found to be a high-quality feed as the NDF of feed stuffs below 45% are considered to be a high-quality feed (Singh and Oosting, 1992).

Based on their CP content, feeds can be grouped into low, medium and high protein sources. According to the report of Lonsdale (1989), feeds with <12%, 12-20% and >20% CP content are classified as low, medium and high protein sources, respectively. Therefore, Birint and Atella used as a supplement feed in the current study are among the high protein source feeds used as protein supplement for low quality feeds like oat straw. But oat straw used as the basal diet is grouped under low quality feeds. That is why sheep under these treatments showed improved feed intake and digestibility.

Dry Matter and Nutrient Intake

Daily DM and nutrient intake of sheep fed oat straw alone or supplemented with Atella, Birint and their mixture is indicated in Table 3. Feed intake is one of the most important parameters to determine the nutritive value of animal feed. The higher the intake the higher the feed quality and it determine the productivity of animals (Savadogo et al., 2000). The daily DM intake of the supplement feeds was 400 g DM as the supplement feeds were totally consumed by animals with no left over.

The DM intake of oat straw was higher (p<0.001) in control treatment than the supplemented groups. This might be associated with the fact that sheep offered basal diet of oat straw alone were attempting to meet their nutrient requirements through the intake of relatively more basal diet. However, the DM intake of oat straw was significantly reduced (P<0.001) with supplementation. Reduction in the intake of oat straw under the supplemented groups in the current study could be due to the higher nutrient content of the supplement feed in which animals could satisfy their nutrient requirements from the relatively small amount of the feed they consumed. Similar to the current finding, Almaz (2008) and Amde (2015) reported that, supplementation of sheep with different concentrate supplement reduced the total dry matter intake of the basal diet significantly.

In the current study, supplementation resulted higher (p<0.001) total DM intake compared to non-supplemented treatment (T1). The higher total dry matter intake in the supplemented sheep might be due to the additional DM consumed from the supplement feed. The positive effect of supplementation on feed intake might be associated with the creation of favorable rumen environment, which could improve rumen fermentation and increase passage rate which induce greater DM intake (McDonald et al., 2002). Besides, highly digestible supplemented feeds are fermented quickly in the rumen, providing space for forage intake.

Among the supplemented treatments, sheep supplemented with 400g Atella (T2) and those sheep supplemented with 200g Birint+200g Atella (T4) had the highest total DM intake, while sheep supplemented with 400g Birint had lower total dry matter intake. Difference in total DM intake among supplemented treatments was in consistent to the intake of the basal diet. In agreement with the current finding, different researcher concluded that, supplementation of sheep with concentrate supplement resulted higher total DM intake but reduced the intake of the basal diet (Almaz, 2008; Mulu et al, 2008; Jalel, 2013; Hagos, 2014; Amde 2015).

The total OM intake followed a similar trend with DM intake as it is the reflection of total DM intake. Supplementation increased total CP intake significantly (P < 0.001). Among the supplemented treatments, sheep on sole Birint supplementation (T3) had higher (p<0.001) total CP intake than sole Atella supplemented treatments, while sheep supplemented with mixture of Atella and Birint had intermediate total CP intake. Differences in total CP intake were also a result of difference in intake of the basal diet and the nitrogen content of the treatment feeds. Intakes of total NDF and ADF were lower for control treatment as compared to the supplement treatments and this is being proportional to variation in total DM intake.
The total DM intake per unit metabolic body weight (BW) and as a percentage of BW in the present study was greater (P<0.01) for the supplemented treatments than the non-supplemented group. But significant difference (P>0.05) was not observed among the supplemented groups. The result obtained in the current study in total DM intake as a percentage of BW was within the range of 2.6 to 3.6% of BW reported by Almaz (2008) for local sheep fed finger millet straw basal diet and supplemented with dried Atella, noug seed cake and their mixture. The values of DM intake as metabolic body weight (48.74-73.7 g/kg W<sup>0.75</sup>) in the present study were comparable with the values of 50.59-72.92 g/kgW<sup>0.75</sup> reported by Abebe (2011).

### Dry Matter and Nutrient Digestibility

Apparent DM and nutrient digestibility of feed used in the current study is indicated in Table 4. The DM, OM, CP and NDF digestibility were significantly higher (P<0.001) for supplemented treatments compared to the control group (T1). The difference in digestibility of DM and nutrients between supplemented and control group might be due to the difference in nutrient supply. The higher DM and nutrient digestibility of supplemented treatment indicated that loss of undigested nutrient is decreased due to supplementation of Atella and Birint.

CP digestibility of supplemented sheep was significantly higher (P<0.001) as compared to non-supplemented sheep even though, there was no significant difference (P>0.05) among the supplemented treatments. The increased digestibility of CP in the supplemented group compared to non-supplemented treatments could be due to the high total CP intake of the supplemented animals. This result agrees with the report of Ash and Norton (1987) who noted that feeding of high protein diet to sheep significantly improved the digestibility of feed compared to low protein diet.

The CP content of feed is an important factor to increase the microbial population in the rumen to support optimum ruminal activity. Lower CP values are associated with decreased microbial function and lead to a reduction in degradation and consequently lowers feed intake (Seyoum et al., 2007). Generally, concentrate feed which is rich in protein promotes high microbial population (McDonald, 2002) which facilitates rumen fermentation. However, dietary protein concentration had no significant effect on the digestibility of ADF in the current study. This

### Table 2: Daily dry matter and nutrient intakes of Washera sheep fed oat straw alone or supplemented with Atella, Birint and their mixture.

<table>
<thead>
<tr>
<th>Intake(g/d)</th>
<th>Treatments</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>SEM</th>
<th>SL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter intake (g/day)</td>
<td>Oat straw</td>
<td>399&lt;sup&gt;a&lt;/sup&gt;</td>
<td>345&lt;sup&gt;b&lt;/sup&gt;</td>
<td>330&lt;sup&gt;c&lt;/sup&gt;</td>
<td>340&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.91</td>
<td>***</td>
</tr>
<tr>
<td>NSC</td>
<td>50.00</td>
<td>50.00</td>
<td>50.00</td>
<td>50.00</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Supplement</td>
<td>-</td>
<td>400.00</td>
<td>400.00</td>
<td>400.00</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Total DM</td>
<td>449.02&lt;sup&gt;c&lt;/sup&gt;</td>
<td>795.49&lt;sup&gt;a&lt;/sup&gt;</td>
<td>780.56&lt;sup&gt;b&lt;/sup&gt;</td>
<td>790.83&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.91</td>
<td>***</td>
<td></td>
</tr>
<tr>
<td>Total DM (g/kgBW&lt;sup&gt;0.75&lt;/sup&gt;)</td>
<td>48.74&lt;sup&gt;b&lt;/sup&gt;</td>
<td>73.29&lt;sup&gt;a&lt;/sup&gt;</td>
<td>69.99&lt;sup&gt;a&lt;/sup&gt;</td>
<td>73.37&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.30</td>
<td>***</td>
<td></td>
</tr>
<tr>
<td>Total DM (%BW)</td>
<td>2.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.99</td>
<td>***</td>
<td></td>
</tr>
<tr>
<td><strong>Nutrient intake (g/day)</strong></td>
<td>Total OM</td>
<td>416.32&lt;sup&gt;d&lt;/sup&gt;</td>
<td>746.88&lt;sup&gt;a&lt;/sup&gt;</td>
<td>722.84&lt;sup&gt;c&lt;/sup&gt;</td>
<td>737.48&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.62</td>
<td>***</td>
</tr>
<tr>
<td>Total CP</td>
<td>33.63&lt;sup&gt;d&lt;/sup&gt;</td>
<td>117.04&lt;sup&gt;c&lt;/sup&gt;</td>
<td>123.92&lt;sup&gt;c&lt;/sup&gt;</td>
<td>120.62&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.19</td>
<td>0.19</td>
<td></td>
</tr>
<tr>
<td>Total NDF</td>
<td>334.28&lt;sup&gt;b&lt;/sup&gt;</td>
<td>456.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>455.64&lt;sup&gt;a&lt;/sup&gt;</td>
<td>458.47&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.07</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Total ADF</td>
<td>279.04&lt;sup&gt;d&lt;/sup&gt;</td>
<td>351.89&lt;sup&gt;a&lt;/sup&gt;</td>
<td>301.89&lt;sup&gt;c&lt;/sup&gt;</td>
<td>328.66&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.58</td>
<td>***</td>
<td></td>
</tr>
<tr>
<td><strong>Substitution rate</strong></td>
<td>-</td>
<td>0.13&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.17&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.15&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.008</td>
<td>***</td>
<td></td>
</tr>
</tbody>
</table>

**a, b, c, d** = means with different superscripts in a row are significantly different. *** = (P<0.001); ADF=acid detergent fiber; CP=crude protein; DM=dry matter; NDF=neutral detergent fiber; OM=organic matter; SEM=standard error of mean; SL=significance level; T1=control (oat straw sole)+50gNSC; T2=oat straw + 400g Atella +50g NSC; T3=oat straw + 400g Birint +50g NSC; T4=oat straw +200g Atella+200g Birint+50g NSC.

### Table 3: Apparent dry matter and nutrient digestibility by Washera sheep fed oat straw alone or supplemented with Atella, Birint and their mixtures.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Treatments</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>SEM</th>
<th>SL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Digestibility (%)</strong></td>
<td>DM</td>
<td>64.24&lt;sup&gt;a&lt;/sup&gt;</td>
<td>65.96&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>67.44&lt;sup&gt;a&lt;/sup&gt;</td>
<td>66.38&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.51</td>
<td>***</td>
</tr>
<tr>
<td>OM</td>
<td>60.86&lt;sup&gt;b&lt;/sup&gt;</td>
<td>64.00&lt;sup&gt;a&lt;/sup&gt;</td>
<td>65.07&lt;sup&gt;a&lt;/sup&gt;</td>
<td>63.69&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.84</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>CP</td>
<td>47.21&lt;sup&gt;b&lt;/sup&gt;</td>
<td>66.68&lt;sup&gt;a&lt;/sup&gt;</td>
<td>70.36&lt;sup&gt;a&lt;/sup&gt;</td>
<td>68.02&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.21</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>NDF</td>
<td>58.16&lt;sup&gt;b&lt;/sup&gt;</td>
<td>65.58&lt;sup&gt;a&lt;/sup&gt;</td>
<td>60.29&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>62.59&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.02</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>ADF</td>
<td>52.69</td>
<td>59.83</td>
<td>58.92</td>
<td>57.67</td>
<td>0.06</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td><strong>Digestible nutrient intake (g/d)</strong></td>
<td>DM</td>
<td>288.45&lt;sup&gt;b&lt;/sup&gt;</td>
<td>524.71&lt;sup&gt;a&lt;/sup&gt;</td>
<td>526.41&lt;sup&gt;a&lt;/sup&gt;</td>
<td>524.95&lt;sup&gt;a&lt;/sup&gt;</td>
<td>11.97</td>
<td>***</td>
</tr>
<tr>
<td>OM</td>
<td>253.38&lt;sup&gt;b&lt;/sup&gt;</td>
<td>478&lt;sup&gt;a&lt;/sup&gt;</td>
<td>470.35&lt;sup&gt;a&lt;/sup&gt;</td>
<td>469.71&lt;sup&gt;a&lt;/sup&gt;</td>
<td>13.88</td>
<td>0.80</td>
<td></td>
</tr>
<tr>
<td>CP</td>
<td>15.88&lt;sup&gt;b&lt;/sup&gt;</td>
<td>78.04&lt;sup&gt;c&lt;/sup&gt;</td>
<td>87.19&lt;sup&gt;c&lt;/sup&gt;</td>
<td>82.04&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.5</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>NDF</td>
<td>194.44&lt;sup&gt;d&lt;/sup&gt;</td>
<td>299.63&lt;sup&gt;a&lt;/sup&gt;</td>
<td>274.72&lt;sup&gt;c&lt;/sup&gt;</td>
<td>286.95&lt;sup&gt;b&lt;/sup&gt;</td>
<td>8.02</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>ADF</td>
<td>147.02&lt;sup&gt;c&lt;/sup&gt;</td>
<td>210.59&lt;sup&gt;a&lt;/sup&gt;</td>
<td>177.83&lt;sup&gt;b&lt;/sup&gt;</td>
<td>189.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>19.22</td>
<td>0.01</td>
<td></td>
</tr>
</tbody>
</table>

**a, b, c, d** = Means within a row not bearing a common superscript letter are significantly different; *** = (P<0.001); ns= non significant; ADF = Acid detergent fiber; CP = Crude protein; DM = Dry matter; NDF = Neutral detergent fiber; OM= Organic matter; SEM= standard error of mean; SL = significance level; T1=control (oat straw sole)+50gNSC; T2=oat straw + 400 g Atella +50g NSC; T3=oat straw + 400 g Birint +50g NSC; T4=oat straw +200g Atella+200g Birint+50g NSC.
might be attributed to the supplementation of low amount of protein in the control diet, which was sufficient for normal ruminal microbial fermentation. Thus, further supplementation of protein did not improve fiber digestibility significantly though it numerically increased about 12% digestibility compared with the control. Catalytic amount of protein usually increases fiber digestibility and growth performance in ruminants fed low quality forages (Patra, 2009a,b). Similarly, Bonsi et al. (1996) reported that, supplementation of cottonseed cake; leucaena or sesbania to Ethiopian Menz sheep had no significant effect on the digestibility of ADF.

In accordance with the current study, different research results indicated that supplementation improved the digestibility of DM, OM and CP. Amde (2015) concluded that supplementation significantly improved the apparent digestibility of DM, OM, NDF and CP when sheep was supplemented with different proportion of corn milling by-product and noug seed (guizotia abyssinica) cake. Abebaw (2007) reported that, significantly higher digestibility of DM and CP when Farta sheep were supplemented with noug seed cake, rice bran and their mixture. Generally, supplementation improved the digestibility of DM, OM, CP and NDF in the current study. This clearly indicates that supplementation of local brewery by products (Atella and Birint) has played a significant role in improving digestibility of oat straw-based diets.

In the current study, the digestible DM, OM, CP, NDF and ADF were higher (P<0.001) for supplemented treatment than non-supplemented groups. Comparable with the current finding, Almaz (2008) reported, supplementation of Atella, noug seed cake and their mixtures fed finger millet straw basal diet improved digestible intake of DM, OM, CP, NDF and ADF.

**Body Weight Change and Feed Conversion Efficiency**

Average daily body weight gain (ADG), final body weight and feed conversion efficiency of experimental sheep on the different treatment feed is given in Table 5. There was no significance difference in initial body weight among the treatments. Supplementation resulted higher (P<0.001) average daily body weight gain, final body weight and feed conversion efficiency than non supplemented treatments. Even though, all sheep were supplemented with a fifty gram of noug seed cake for maintenance, the control group (T1) loses weight during the experimental period. The lower performance of sheep fed on the control group might be due to the low DM and nutrient intake as compared with those on supplemented treatments.

Among the supplemented groups, supplementation with Birint (T3) had higher (P<0.001) than Atella (T2) while mixed (T4) had comparable ADG with T2 and T3. Feed conversion efficiency (FCE) followed somewhat similar trend like that of ADG, being the lowest for T1 than the supplemented treatments, and among the supplemented treatments value for T3 was greater (P < 0.001) than that of T4 and T2, respectively. The higher performances of sheep in T3 as compared to sheep in T2 might be due to the higher total digestible CP intake in Birint supplemented sheep than Atella. The current result also showed that combining the two supplements (Atella and Birint) as in T4 result better performance of animals as compared to sole Atella supplementation. This could be due to the lower CP content of Atella, and therefore lower digestible CP intakes and lower in digestibility as compared to other supplemented treatments. In contrast to the supplemented treatments, non supplemented group lose 0.88g/day throughout the experimental period. Loss of body weight in the control treatment could be explained by the lower CP and higher fiber contents of oat straw.

**Table 4: Body weight parameters and feed conversion efficiency of Washera sheep fed oat straw basal diet and supplemented with Atella, Birint and their mixture.**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>SEM</th>
<th>SL</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBW (kg)</td>
<td>19.44</td>
<td>19.3</td>
<td>18.84</td>
<td>18.8</td>
<td>1.77</td>
<td>Ns</td>
</tr>
<tr>
<td>FBW (kg)</td>
<td>19.36&lt;sup&gt;a&lt;/sup&gt;</td>
<td>24.12&lt;sup&gt;b&lt;/sup&gt;</td>
<td>25.14&lt;sup&gt;c&lt;/sup&gt;</td>
<td>24.06&lt;sup&gt;d&lt;/sup&gt;</td>
<td>2.3&lt;sup&gt;c&lt;/sup&gt;</td>
<td>***</td>
</tr>
<tr>
<td>ADG(g/day)</td>
<td>0.08&lt;sup&gt;c&lt;/sup&gt;</td>
<td>53.33&lt;sup&gt;b&lt;/sup&gt;</td>
<td>70.00&lt;sup&gt;a&lt;/sup&gt;</td>
<td>58.44&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>9.66&lt;sup&gt;c&lt;/sup&gt;</td>
<td>***</td>
</tr>
<tr>
<td>FCE(g)</td>
<td>0.002&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.06&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.09&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.07&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>0.01&lt;sup&gt;c&lt;/sup&gt;</td>
<td>***</td>
</tr>
</tbody>
</table>

a, b, c Means within the same row not bearing a common superscript differ significantly; *** =(P<0.001); ns = not significant; SEM = standard error of mean; T1 = control (sole oat straw) +50g NSC; T2 = oat straw +400 g DM Atella +50g NSC; T3 = oat straw + 400 g DM Birint +50g NSC; T4 = oat straw +200 g DM Atella+200gDM Birint +50g NSC; FCE = feed conversion efficiency.

The minimum protein level for maintenance requirement of sheep is about 8% crude protein (CP) in the DM (NRC, 1985) and 11% CP in the DM is required for production, but the CP content of oat straw was below the estimated level. Due to these reasons, sheep obtained only oat straw lose their body weight significantly. The body weight loss for control treatment indicates that supplementation with protein source is necessary for sheep fed oat straw for growth. In agreement with the current study, Almaz (2008) reported that feeding of sheep only with finger millet straw lost an average daily body weight of 23.3g/day.

The ADG (53.33-70 g/day) obtained for supplemented sheep in the current study was comparable with the finding of Mulu et al. (2008) who reported body weight gain of 44.4-70.44 g/day in Wogera sheep fed grass hay as basal diet supplemented with graded levels of brewery dried grain. It is also very close to the body weight gain of 50.89-67.31g/day for Horro lambs supplemented with corn milling by-product and noug seed cake fed the basal diet of natural pasture grass hay (Amde, 2015). Higher than the current finding, average daily body weight gain of 84.3g/day was reported by Ajebu (2010) where sheep
were supplemented with malt sprout and *Birint* fed Rhodes grass basal diet. On the other hand, lower average daily body weight gain of 45g/day was reported by Hagos (2014) where sheep were supplemented with *Atella* fed natural pasture hay basal diet. Difference in ADG among studies might be due to the difference in nutrient concentration of feeds, the environment where the research was conducted as well as the breeds of the experimental sheep.

**CONCLUSION AND RECOMMENDATION**

Feeding of local brewery by products to livestock such as small ruminants is essential to develop alternative and relatively cheaper source of supplement that do not only improve animal performance but also economical during harsh environmental conditions when insufficient amount of natural pasture and crop residues are available.

In general, in the current study, *Birint* supplementation resulted in higher ADG, net income and marginal rate of return (MRR) compared to other supplement regimes. Therefore, from the results of the current study it can be suggested that feeding oat straw basal diet plus 50 g noug seed cake and supplemented with 400 g *Birint* to Washera sheep appeared to be recommendable in current study. However, all supplements used in this study induced good ADG and they can be employed in feeding systems depending on their availability and relative cost for improving market condition of Washera sheep.

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