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Participatory Evaluation of Dual Purpose Pigeon Pea (*Cajanus Cajan*) Leaves for Sheep Feeding

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Abstract
The study on the potential use of pigeon pea leaves as sheep feed was carried out with eighteen local Sheep with an average initial weight of 15.2 ± 0.97 kg were randomly assigned to three dietary treatments. The experiment entailed a completely randomized design with 6 replications per treatment. Pigeon pea leaves (PPL) at three levels: 0%, 35% and 52%. The PPL 0% considered as a control group fed a natural grass. On dry matter (DM) basis PPL and natural grass contained 21.61 and 9.25% CP, 4.25 and 8.29% EE, 54.80 and 65.57% NDF and 39.75 and 36.08 ADF, respectively. Forage biomass production of pigeon pea was 8.35t/ha with crude protein yield of 1.56 t/ha, while the natural grass yield was 4.21 t/ha with CP yield of 0.33 t/ha. Supplementation of PPL significantly (P<0.05) increased average daily gain of sheep but there was no significant (P<0.05) difference between sheep supplemented with PPL 0% and PPL 35% in terms of weight gain. Average daily live weight gain was significantly greater (P<0.05) for PPL52%. There was a significantly higher (p<0.05) PPL intake and weight gain obtained in treatment PPL52%. Therefore, supplementation of sheep with PPL52% pigeon pea leaves was found to be the best level under farmer condition especially in the lowland areas.
Keywords: Pigeon pea leaves, sheep, weight gain, feed intake

1. Introduction

Pigeon pea (*Cajanus cajan)* locally called "yergib ater" is an important multi-purpose shrub legume grown throughout the tropics and subtropics for its edible legume grain that is used as a human staple food. It is used primarily as a vegetable food crop that serves as a source of protein (Faujdar and Diwakar, 1993). It is the preferred pulse crop in dry land areas where it is intercropped or grown in mixed cropping systems with cereals or other short duration annuals (Joshi et al., 2001). The main products of pigeon pea are dry grain, green pods and fodder (Mergeai et al., 2001). Thus, the crop is used as a cheap source of protein-rich food and fodder for poor smallholder farmers.

The high nutritive value of pigeon pea is perhaps the most to be found among the very poor household in Africa. Pigeon pea is increasingly becoming an important subsistence crop in the whole of Africa with production reported in more than 33 countries (Johansen et al., 1993; Damaris, 2007). Bulk production is however concentrated in Eastern Africa and some countries have been reported to export significant amounts (Shanower et al., 1999; Damaris, 2007). The supplementation of cereals with protein rich legumes is considered as one of the best solutions to protein-calorie malnutrition in the developing world (Chitra et al., 1996; Damaris, 2007).

In Ethiopia, due to climate variability and the frequencies of extreme events have increased over recent times. In order to address these problems drought resistant, early maturing and heat tolerant crop species and varieties have been developed by the research systems in Ethiopia. Due to its drought tolerant nature, pigeon pea is one of the grain legumes that chosen by Ethiopian Institute of Agricultural Research for the livelihood improvement to meet the current nutrient need of human being (FAO, 2010). Dry land legumes are believed to offer enormous opportunity for reducing food insecurity and poverty in the semi-arid tropics especially due to their adoptability to semi-arid conditions and their high likelihood to be adopted by the poor and vulnerable communities (Simtowe et al., 2012).

In addition to human consumption, pigeon pea is grown for animal feed. It may be fed to all domestic animal species, both ruminant and non-ruminants (Damaris, 2007). As animal feed pigeon pea leaves are used as dry or green fodder and the seed by-products from the split seed mills are used as animal feed (Whiteman and Norton 1981; Faujdar Singh and B. Diwakar, 1993).

Limited quantities and quality of feedstuffs are considered to be the major constraints hampering productivity of farm animals in Ethiopia (Tegegne, 2001). In improved animal production system; animal feed cost is the largest component of total production costs; therefore, substitution of feeds that can be produced on farm for concentrate supplements, which are relatively expensive and not readily available to smallholder farmers, could be advantageous. In addition to feed cost a constraint to adopt and grow an improved forage species, the farmers have a shortage of land (Simon, 2000). Pigeon pea leaves is one of such feeds that can be produced on the farm where the seed can be used for human consumption. Some pigeon pea varieties have been released and adopted to some semi-arid and arid regions of Ethiopia, for example Konso, Sirika and Kobo (FAO, 2010). However, they have not been widely disseminated in most lowland areas and thus a very small fraction of the farming population has been experience and knowhow. Therefore, the current study is aimed to evaluate a

pigeon pea leaves as protein source supplementation and to evaluate its nutritional value on body weight gain on sheep feeding on-farm condition.

Materials and Methods

Description of the Study Area

The study conducted in Wolaita zone of the Southern Nations Nationalities and People Regional State (SNNPRS) Damot Weyde district. It is located about 400 Km away from Addis Ababa to the south at about 6050' and 6059' N latitudes, and 37052' and 38000'E longitudes. In Damot Weyde district, there are two Agro-Ecological Zones, Namely lowland and midland. The annual mean maximum and minimum temperature are 24.8^0C and 21.6^0C respectively. The total mean annual rain fall is 720 to 1350mm (NMSA, 2001).

Sampling Technique and Experimental Design

A multi stage sampling procedure was employed in selecting households. The first stage was involved a purposive sampling of one district based on the agro-ecological zone (from lowland). The second stage was involved a random selection of one Peasant Association (PA) of the district. Finally, in the sampled PA, purposive samples of two model farmers were drawn from a list of farming households.

The experiment trial were carried out on CRD and the animals were randomly assigned to three different treatment groups with six replication.

The experimental treatment feeds were given according to nutrient requirement of sheep.

Treatment 1 (PPL 0%): Basal diet (natural grass)

Treatment 2 (PPL 35%): Basal diet + 35% pigeon pea leaves

Treatment 3 (PPL 52%): Basal diet + 52% pigeon pea leaves

Experimental feed production

The seed of improved variety of pigeon pea was grown on 0.5 ha of land in each of the selected farmers land. For the purpose of feeding sheep, the leaves part of pigeon pea plant was collected at 6 months after planting. After the crop getting matured, the leaves of pigeon pea was harvested daily from the field and then chaffed and given to experimental sheep as a protein supplemental feed with locally available feeds. The basal diet i.e. natural pasture was provide by grazing and the experimental feed (pigeon leaves) was provided by cut and carry system.

Experimental Animals management and provision of feed

Eighteen yearling male local growing sheep with the average initial body weight of 15.2 ± 0.97 kg were purchased from "Delbo" local market. The sheep were treated against internal and external parasite and dewormed before commencement of the experiment.

The experimental animals were distributed randomly respective to the treatment groups. Before starting the actual data collection, a 14 days adaptation period was given to the experimental animals. The treatment group sheep were grazing/ browsing (PP L0%) for 8 h, and/or supplemented with 0.72 and 1.08 kg of fresh leaves of pigeon pea. The supplements at PPL 35% and PPL52% were intended to provide 35 and 52% of the total dry matter intake of the sheep. Sheep in the control group stayed in the field during the day time while during the night they were sheltered in their house and sheep in the treatment groups (PPL 35% and PPL52%) were placed in their respective supplemental feed after 8 hrs grazing and throughout the night in their respective pen.

Data Collection

Forage yield

The leave part of the pigeon pea was harvested and weighed for each plant and to calculate the total yield (t/ha), multiply the yield of each plant by the plant spacing.

Body weight gain

The experimental animals were weighed at the start of the experiment and then weekly base in the morning before feeding for analysis of body weight gain.

Feed intake

The experimental feeds were weighed before feeding in every morning. Feed refusals were collected from individual animals every morning and weighed to quantify feed intake. Feed offered and refusals were sampled, bulked for each animal daily and sub-sampled for chemical analysis for analysis of nutrient intake. The experiment lasted for 90 days.

Chemical Analysis of the Feed

The collected feed samples were analyzed for dry mater (DM), crude protein (CP), ether extract (EE), crude fibre (CF) and ash content by following the standard analytical method (AOAC, 2005), neutral detergent fibre (NDF) acid detergent fibre (ADF) and acid detergent lignin (ADL) analyze by method developed by Goering and Van Soest (1970), in-vitro dry matter digestibility was done in Holeta agricultural research center.

Statistical Analysis

The collected data was subjected to analysis of variance using SPSS statistical software version 16.0 for Windows (SPSS, 2007).

Results and Discussions

Chemical composition of experimental diets

Pigeon pea leaves and natural grass contain 35.54% and 35.35% dry matter (DM), respectively. On DM basis pigeon pea leaves contained 92.65% organic matter, 18.68% crude protein, 4.25% total fat, and 54.80% neutral detergent fibre.

Table 1: Chemical composition of dietary ingredients (Pigeon pea leaves and natural grass)

Nutrients (%)	**Pigeon pea leaves**	**Natural grass**
DM	35.54±0.92a	35.36±0.70a
Ash	7.35±0.04b	8.55±0.05a
OM	92.65±0.63a	91.45±0.45b
CP	18.68±0.50a	7.84±0.55b
Fat	4.25±0.07b	8.29±0.01a
Fiber	30.51±0.88b	36.25±0.74b
NDF	54.80±0.09b	65.57±0.11a
ADF	39.75±0.50a	36.08±0.75a
Hemicellulose	15.05±0.05b	29.50±0.10a
Lignin	13.25±0.70a	6.04±0.51b
IVDMD	51.33±0.44a	51.95±0.63a
Tannin (mg/100gm)	0.79±0.006a	0.16±0.002a
Forage yield/DM basis (t/ha)	8.35±0.11a	4.21±0.13b

Means on the same rows with differing superscript letters are significantly different (P<0.05).

Pigeon pea leaves and natural grass contain 35.54% and 35.35% dry matter (DM), respectively. On DM basis pigeon pea leaves contained 92.65% organic matter, 18.68% crude protein, 4.25% total fat, and 54.80% neutral detergent fibre. Natural grass contained 9.25% crude protein, 8.29% total fat and 65.57% neutral digestible fibre while the lignin content of lignin is 13.25% and 6.04% for pigeon pea leaves and natural grass, respectively.

Pigeon pea levees contained 0.79% tannin. In-vitro DM matter digestibility of pigeon pea leaves is 51.33% and similarly the corresponding value of natural grass is 51.95%.

The value of CP in this experiment was similar with the value reported by Cheva-Isaraku, (1992) while up to 24.6% protein content has been reported (Tangtaweewipat and Cheva-Isaraku, 1992). The CF content of the pigeon pea leaves (PPL) was in agreement with the value reported by Shenkute et al., (2013) and Wong (1990). According to Van Soest (1982), high fiber content in forages is the primary factor limiting feed intake; however, pigeon pea has relatively lower fiber content than other multipurpose trees.

The digestibility of pigeon pea leaves in this experiment 51.3% was similar to that reported by Wong (1990) 50.5% and Cheva- Isarakul (1992) 50.2%. The content of tannin, which is the common anti-nutritional factor in legume tree and shrubs, was 0.79 % and the corresponding value for natural grass was 0.16%.

Tannin content in ruminant diet above 3% has a negative effect on reducing appetite, a decrease in the degradation rate of the degradable matter in the rumen, depressive effect on the intestinal activity of pancreatic enzymes and hamper amino acid absorption from the intestine (Silanikove et al., 1999). However, the value obtained in pigeon pea leaves was below the level that can cause negative effect. Furthermore, anti-nutritional factors and poly-phenols are less problematic in pigeon pea than other tree legumes (Faris and Singh, 1990).

Pigeon pea is widely used as fodder for livestock (Rao et al., 2002) due to its excellent fodder with high nutritional value and high digestibility (Onim et al., 1985; Shenkute et al., 2013). In addition to the leaves, seeds, skins, pods can also use as animal feed. Moreover, the seeds are a rich source of carbohydrates, minerals and vitamins for human food in addition to its various medicinal properties (Saxena et al., 2010). Pigeon pea contains more minerals, ten times more fat, five times more vitamin A and three times more vitamin C than ordinary peas (Foodnet, 2002; Damaris, 2007).

Pigeon pea leaves biomass production

Forage biomass production of pigeon pea was 8.35t/ha with crude protein yield of 1.56 t/ha, while the natural grass yield was 4.21 t/ha with CP yield of 0.33 t/ha (table 1). The CP yield in our study was greater the range of values (0.8-1.3t/ha) reported by Wan Mohamed and Ravoof (1987; Wong, 1990). The DM production of pigeon pea leaves was in a range of values (3.7- 9.8t/ha) reported by Wan Mohamed and Ravoof (1987; Wong, 1990). Similarly, Hector, (2011) reported the value 5.1 tons/ha in Nigeria. According to Rao (2002) reports forage yield of pigeon pea leaves were high relative to other grasses and legumes, ranging from 1120 kg/ha. In our study, the forage DM yield and CP production (t/ha) of pigeon pea was higher than the value obtained from natural grass forage. The forage production in pigeon pea was twice and CP production was more than four times than the value recorded from natural grass. The yield of pigeon pea was better than the natural grass in terms of quantity and quality.

The highest nutritive value of pigeon pea is perhaps the most important reason why it should find an important place among the smallholder poor farmers in Africa. Pigeon pea is wonderfully abundant in protein, making it an ideal supplement to traditional cereal-, banana- or tuber- based diets of most Africans which are generally protein-deficient.

Feed intake and body weight changes

There was a significant ($p<0.05$) different between treatments on intake of pigeon pea leaves. The PPL intake was significantly lower ($p < 0.05$) for PPL 35% than for PPL52%.

Table 2 Mean (SE) feed intake and body weight changes of experimental sheep

	Treatments		
Feed offered	**PPL 0%**	**PPL 35%**	**PPL52%**
Pigeon pea leaves as fed (Kg)	-	0.72	1.08
Feed intake			
Pigeon pea leaves as fed (Kg)	-	0.63 ± 0.049^{b}	0.95 ± 0.044^{a}
Pigeon pea leaves on DM basis (Kg)	-	0.22 ± 0.017^{b}	0.34 ± 0.015^{a}
Body weight changes			
Initial body wt. (Kg)	14.90 ± 0.61^{a}	14.60 ± 0.78^{a}	15.40 ± 0.19^{a}
Final body wt. (Kg)	19.88 ± 0.31^{b}	20.70 ± 0.88^{b}	24.13 ± 0.66^{a}
Average daily wt. gain (g/head)	55.37 ± 4.39^{b}	67.78 ± 6.37^{b}	97.04 ± 6.81^{a}

Means on the same rows with differing superscript letters are significantly different ($P<0.05$).

There was a significant ($p<0.05$) different between treatments on intake of pigeon pea leaves. The PPL intake was significantly lower ($p < 0.05$) for PPL 35% than for PPL52%.

The higher body weight gain was observed on the treatment PPL52%, while there were no significant ($p<0.05$) different between the two (PPL 35% and PPL 0%) treatment groups (Table 2). The higher PPL or CP intake was reflected in superior live weight gains with best results being obtained for diet PPL52%. Experimental animals fed with PPL52% gained at a rate of 97.04g/day. Similarly, Shenkute et al., (2013), when sundried pigeon pea leaves was supplemented at 30 and 40% DMI of goats diet, weight gain was 92 and 84g/day, respectively. In other PPL supplementation study (Pamo et al., 2002; Shenkute et al., 2013), almost twice weight gain was observed for kids' supplemented during the dry season than the un-supplemented due to the protein level in the multipurpose trees which was 84 to 140% higher than in the grasses. This clearly justifies the use of pigeon pea as feed supplements in ruminant nutrition during periods of forage scarcity. Most likely factors responsible for differences in average daily body weight gain are intakes of DM and CP as influencing digestible DM and N. There was a relationship between average daily body weight gain and intakes of pigeon pea leaves. The relationship between live weight gain and DM and CP intakes were similar to those obtained by Shenkute et al. (2013). This is also supported by the work of Cheva-Isarakul (1992).

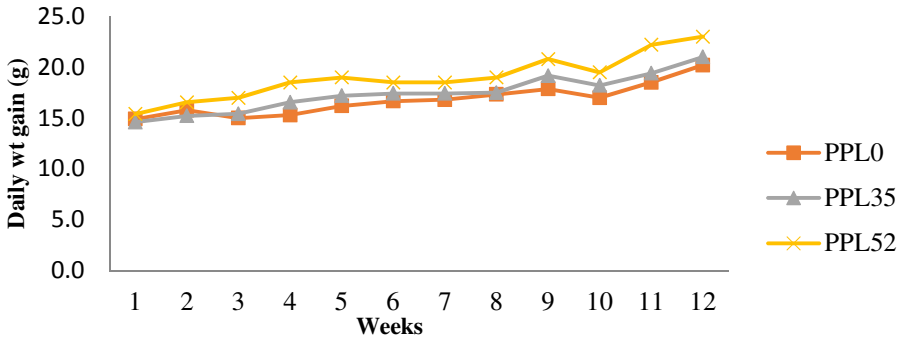

Figure 1: Trend in Body Weight Change of Growing Sheep

The trend in body weight change of experimental animals during the feeding period is given in figure 1. At the beginning of the experiment, weight gain by all treatment groups was relatively similar, followed by only small fluctuation as the experimental period of feeding progressed. However, the trends for highest and lowest average body weight gain for PPL52% and PPL 0%, respectively, were fairly consistent throughout the 90-day experiment.

Conclusion

The use of shrubs and tree fodders will eventually be linked to expanding the ruminant livestock production in most of lowland. Hence, the success of shrub and tree fodder research continues to serve the needs of the small-scale livestock producer. Under the current condition, the use of pigeon pea is advantageous especially in the lowland areas of Ethiopia when there is high demand for forage and farmers can benefit from leaves when they use the seeds for human consumption. Drought poses one of the most important environmental constraints to plant survival and productivity (and hence food security) in the tropics. Pigeon pea remains one of the most drought-tolerant legumes.

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