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Nutritional Composition Analysis of Tsara (Pterocarpus lucens), Pigeon Pea (Cajanes cajan) Leaves, Concentrate Mixture and Natural Pasture Hay at Tselemti District North Western Zone of Tigray Regional State, Ethiopia

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Abstract
The study was conducted at Shire-Maitsebri Agricultural Research Center Tselemti District of north western zone of Tigray regional state with the objective of evaluating the nutritional composition of Tsara (pterocarpus lucens), Pigeon pea (Cajanus cajan) leaves, concentrate mixture and Natural pasture hay. The chemical composition analysis result of the feed samples showed that CP (crude protein) contents of 5.56, 16.5, 20.6 and 21.8% for hay, Tsara, pigeon pea and concentrate mixture respectively. higher NDF ADF and ADL content were observed in hay 78.74, 53.90 and 14.5% respectively than the fiber content in the browse feeds and a relatively lower NDF, ADF and ADL content were observed in the concentrate mixture which were 48.90,14.60 and 7.58% respectively. The contents of Condensed tannin were in the order of Pigeon pea (7.7%) >Tsara (6.8%) > hay (1.96%)>Concentrate mixture (0.8%) on the other hand higher Calcium(Ca) contents were recorded for Tsara (1.81% DM) than Hay, Pigeon pea and Concentrate mixture which were 0.60, 0.86 and 0.62% DM respectively. whereas the Phosphorus (P) content of the feed samples were relatively higher in concentrate mixture, Tsara and Pigeon pea than hay which were 0.17, 0.15, 0.13 and 0.07% DM respectively. In conclusion based on the chemical analysis result the browse feeds Tsara (Pterocarpus lucens) and Pigeon pea (Cajanus cajan) can be used as a supplemental feed resources in ruminant feeding to maintain continuous improvement in fertility and growth rate of animals throughout the year. Therefore, further animal response studies must be conducted in relation to feed intake, digestibility, growth rate and the anti nutritional effect of condensed tannin in these supplemental browse feeds.
Keywords: *Tsara* (*Pterocarpus lucens*), Pigeon pea (*Cajanus cajan*), Concentrate Mixture, Natural Pasture Hay

Introduction

Ethiopia ranks first in Africa in livestock population; with an estimated livestock population of 55.03 million cattle, 27.35 million sheep, 28.16 million goats, 1.96 million horses, 6.95 million donkeys, 0.36 million mules, 1.1 million camels and 51.35 million poultry (CSA, 2014). Even though, Ethiopia has this huge livestock population the production and productivity of the animals is very low. This is so because; the development of the livestock sector of the country is very much hampered by various human and natural factors (Alayu 1987). As compared to other African countries the economic contribution from the subsector is generally low and a multitude of constraints exists that influence the productivity of livestock (Yaynshet, 2010), the scarcity of livestock feeds both in quantity and quality is a major bottleneck especially in the dry season (Tesfaye, 1999).

To mitigate the problem of feed availability in the dry season; use of browse plants would be regarded as the best option. Most browses plants have high crude protein content, ranging from 10 to more than 25%; they may be considered as a more reliable feed resource of high quality to develop sustainable feeding systems and in increasing livestock productivity (Okoli *et al*, 2003). Thus, there is a pressing need to evaluate the potential and feed values of the indigenous browse plants (multipurpose trees and shrubs) so that they could be used in developing sustainable feeding standards (Aynalem and Taye, 2008).

In Tigray region of Ethiopia *Tsara (Pterocarpus lucens)* is an indigenous fodder tree used by livestock owners to feed their animals. In addition, pigeon pea (*Cajuns cajan*), natural pasture hay, different concentrate feeds like rice bran and sesame seed cake are available in the north western zone of Tigray specially in Tselemti District. However, no research works appears to have been done on the nutritional composition of the indigenous fodder trees in the area. Therefore; the objective of the study was; to evaluate the nutritional composition of *Tsara* (*Pterocarpus lucens*) and pigeon pea (*Cajanus cajan*) leaves, concentrate mixture and natural pasture hay.

1. Materials and Methods

1.1. Description of the Study Area

The study was conducted at Shire-Maitsebri Agricultural Research Center (SMYARC), Tselemti District, North Western zone of Tigray Regional State, Ethiopia. The District is located 405 km far to the North West of Mekelle, the capital of the region, 85 km far to the South of Shire along the Gondar way and 1172 km far from Addis Ababa, capital of Ethiopia. Elevation ranges from 800 to 2870 meters above sea level (masl). Its

geographical location is 13° 05' N latitude and 38° 08' E longitude. The average annual rainfall in the area is 758 to 1100 mm, with mono modal pattern falling from June to September. The annual temperature ranges from 16 to 38 °C.

1.2. Feed Samples Collection and Preparation

Pterocarpus lucens (Tsara) leaves were collected from area enclosures, water shades, communal grazing areas and individual farm lands around Tselemti district. Leaves were collected from a stand tree by lopping of the minor branches of the plant and by hand plucking of the edible leaf parts. Pigeon pea leaf was collected from Shire Maitsebri Agricultural Research Center experimental site. The collected leaves were then transported on fresh basis and oven dried for about 72 hours The concentrate feed, rice bran sample was collected from Medhanialem rice dehulling cooperatives and sesame seed cake sample was taken from the local sesame oil extractors in the area and were mixed in the ratio of 3 parts rice bran to 1 part sesame seed cake (75 RB: 25 SSC). The natural pasture hay sample was collected from Shire Maitsebri Agricultural Research Center experimental site.

1.3. Chemical Analysis

All feed samples were analyzed for dry matter (DM), ash, and crude protein (CP) according to the procedures of AOAC (1990). The neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) of each sample were also analyzed, according to the procedure described by VanSoest and Robertson (1985). Condensed tannin was analyzed by vanillin-HCl methanol method of Price *et al.,* (1978). The calcium (Ca) content was determined by atomic absorption spectrophotometer (AACC, 2000). Determination of phosphorus (P) is carried out on the digest aliquot obtained through calcinations or wet digestion. The P in the solution was determined by using Ammonium molybdate and metavanadate for color development and finally sample absorbance reading were made at 880nm wave length using the UV- Spectrometer.

2. Results and Discussion

2.1. Chemical Composition of the Feed Samples

2.1.1. DM, Ash, OM and CP Content of Feed Samples

The results of chemical analysis (DM, Ash, OM and CP) of the feed samples are given in Table 1. The DM content of 95.75% of the natural pasture hay is comparable with the results 94.71, 94.35, 93.20 and 93.38 % reported by Gebreslasie, (2012), Hagos, (2014), Birhanu, (2011) and Lidetu, (2011) respectively, and greater than the results reported by Gizat, (2011), Kiflay, (2011) and Melese, (2011) which were 92.59, 92.94 and 91.98% respectively.

The CP content of the natural pasture hay 5.56% was lower than the 7.5-8% maintenance requirement of animals (VanSoest, 1982). Similar results of CP content of hay were reported by Abebe (2006) and Jemberu (2008) which were 6.75 and 5.28%. However, the CP content of hay in this study was lower than the 7.02-9.2% results reported by (Hagos, 2014; Abebaw, 2007; Bimrew, 2008). The CP content of hay may vary due to species composition, growth stage of the plant, harvesting season, method of preparation and preservation, soil fertility where the grass harvested (Stoddard *et al.,* 1975; McDonald *et al.,* 2002). In addition the low CP content of the hay might be due to the maturity of hay at harvesting. Concerning the growth stage, hay quality is highest when harvested before or at the beginning of flowering stage Adugna (2008); unfortunately, the hay sample used in this study was harvested at the full flowering stage of the forage crops due to the prevailing rain fall in the study area that affects harvesting and drying process for proper hay making.

Table 1. Average DM, Ash, OM and CP Content of feed samples at Tselemti District

Type of feed sample	Chemical composition (% for DM and % DM for others)			
	DM	Ash	OM	CP
Hay	95.75	10.25	89.75	5.56
Tsara (*P.lucens*)	95.5	7.50	92.50	16.51
Pigeon pea (*C.cajan*)	95.75	6.75	93.25	20.61
CM	95.25	9.75	90.25	21.80

CP = Crude Protein; CM = concentrate mixture (75% rice bran and 25% sesame seed cake);
DM = Dry Matter; OM = Organic Matter

The CP content of *Tsara* (*Pterocarpus lucens*) leaf used in this study was 16.5%, which is in agreement with the 15.7% CP reported by Sanon (2007), but relatively lower than the 20-25% CP reported by Orwa *et al.,* (2009). This might be due to seasonal variation in sampling and stage of maturity of the fodder plants (Rajuperti, 2006; Pamo *et al*., 2007). The CP content of pigeon pea (*Cajanus cajan*) leaf obtained in this study was comparable to the 21-23% CP reported by others (E.g., Adjolohoun *et al.,* 2008; Ajebu *et al.,* 2012; Shenkute *et al.,* 2013). The CP content of the concentrate mixture (75% rice bran and 25% sesame seed cake) used in this study was comparable with the 20.22% CP reported by Abebaw (2007) by mixing 66.67% rice bran and 33.33%

noug seed cake. Lonsdale (1989), classified feeds as low, medium and high protein sources if they contain less than 12%, 12-20% and greater than 20% CP respectively. Accordingly in this study the CP content of hay is low, Tsara (*Pterocarpus lucens*) medium however pigeon pea (*Cajanus cajan*) and concentrate mixture feeds are classified as high protein sources respectively.

2.1.2. Fiber Content (NDF, ADF and ADL) of Feed Samples

The results of chemical analysis (NDF, ADF and ADL) of the feed samples are given in Table 2. The NDF and ADF contents of the hay in this study were 78.74 and 53.90%, and that of ADL content was 14.5%. According to Beyene (1976), the NDF content of 70% or more in a feed is enough to limit dry matter intake and digestibility. Alemu (1981) has reported that NDF value ranging from 35-42% to have a relatively little impact on intake and digestibility of dry matter. Therefore, the NDF content of the hay in this study is high to impact the intake and digestibility of dry matter. The high fiber content of hay in this study might be due to the maturity of the hay at harvesting time. *Tsara* leaf showed higher NDF, ADF and ADL contents (53.92, 36.83 and 13.49% respectively) followed by Pigeon pea leaves 49.21, 32.65 and 9.10% respectively. The difference in NDF, ADF and ADL contents of the browse feed supplements might be due to stage of maturity; with advancing maturity the digestible dry matter, crude protein, calcium and phosphorus in the browse or shrub decreases while the fiber content increases Rajupreti (2006).

The NDF content of the concentrate mixture in this study was greater than the results reported by Abebaw (2007); Bimrew (2008) and Hagos (2014) which were 39.94, 44.4 and 40.24%, respectively; whereas, the ADF and ADL content was lower than the result reported by Abebaw (2007) and Bimrew (2008) which was 24.8, 35.8 and 9.5, 11.4% respectively.

Table 2. Average Fiber Content (NDF, ADF and ADL) of feed samples at Tselemti District

Type of feed sample	Chemical composition (% of DM)				
	NDF	ADF	ADL	H	Cellulose
Hay	78.74	53.90	14.53	24.84	39.37
Tsara (*P.lucens*)	53.92	36.83	13.49	17.09	23.34
Pigeon pea (*C.cajan*)	49.21	32.65	9.10	16.56	23.55
CM	48.90	14.60	7.58	34.30	7.02

ADF = Acid Detergent Fiber; ADL = Acid Detergent Lignin; CM = concentrate mixture (75% rice bran and 25% sesame seed cake); NDF = Neutral Detergent Fiber; H (hemicellulose) = NDF-ADF, Cellulose = ADF- ADL

The variability in nutritional content of the concentrate mixture might be associated with the type and quality of raw material used, and the method of processing employed (Adugna, 2008). In general Rajupreti (2006) revealed that a feed that contained more than 45% ADF and 65% NDF content is considered as low quality feed. However, the feed stuffs used in this study can be classified as medium to high quality supplemental feeds except hay.

The hemicelluloses and cellulose contents of the sample feeds in this study were 39.37 and 24.84 for Hay, 23.34 and 17.09 for *Tsara*, 23.55 and 16.56 for pigeon pea and 7.02 and 34.3% for concentrate mixture respectively.

2.1.3. Condensed Tanin, Calcium and Phosphorus Content of Feed Samples

The results of chemical analysis (CT, Ca and P) of the feed samples are given in Table 3. In this study lower CT levels were recorded for hay and concentrate mixture, than the CT levels in *Tsara* (*Pterocarpus lucens*) leaves and pigeon pea leaves. The CT concentration of pigeon pea leaves in this study was higher than the results reported by Balogun (2013) and Alexander *et al*., (2007) which was 1.05 mg/kg of DM, and 0.4-4.3% of DM for pigeon pea seed and pigeon pea leaves, respectively. The CT concentration of Tsara (*Pterocarpus lucens*) in this study was comparable to the results reported by Jackson *et al*., (1996) which was 5.73 and 6.6% of CT for *Leucenia leucocephala* and *Leucenia pallidae,* leaves respectively, and higher than the results reported by Arigbede *et al*., (2012) 23.4-26.9 g/kg of DM for *Pterocarpus santalinoides*. The CT concentration of the Tsara and pigeon pea in this study was lower than the 11-19% level reported for *Acacia saligna* leaf (Getachew, 2005; Shumye, 2011; Gebreslassie, 2012). In general shrub and tree foliages are likely to be higher in tannins than pasture plants; that is both cereals and leguminous forages. It has been believed that forage containing tannin above 5% can be considered as tannin rich forage and become a serious anti nutritional factor in plant materials fed to ruminants (Barry and Manley, 1984; Leng, 1997). Furthermore, Lohan *et al.,* (1980) noted that condensed tannins with 5 to 10% of the feed are considered anti- nutritive and are toxic; whereas this is contradicted with the idea reported by Waghorn *et al.,* (1999) which reveals the presence of CT at dietary concentrations below approximately 10% in the diet may increase the performance of the ruminants. At higher levels tannins become highly detrimental (Barry and Duncan, 1984), as they reduce digestibility of fiber in the rumen (Reed *et al.,* 1985) by inhibiting the activity of bacteria (Chesson *et al.,* 1982) and anaerobic fungi (Akin and Rigsby, 1985) and also lead to reduced intake (Leng, 1997).

Table 3. Average CT, Ca and P Content of feed samples at Tselemti District

Type of feed sample	Chemical composition (% of DM)		
	CT	Ca	P
Hay	1.87	0.60	0.07
Tsara (*P.lucens*)	6.80	1.81	0.15
Pigeon pea (*C.cajan*)	7.71	0.86	0.13
CM	0.75	0.62	0.17

Ca = calcium; P = phosphorus; CM = concentrate mixture; CT = condensed tannin

The Ca and P content of the browse *Tsara* in this study was greater than the Ca and lower than the P content reported by Orwa *et al.,* (2009) which was 1.5 and 0.5% of DM, respectively. Rajupreti (2006) reported that feeds containing 1.5-3.99% Ca and less than 0.5% P were classified as moderate and low quality feeds respectively. Therefore, in the current study feeds that contained *Tsara* were adequate in Ca levels but low in P levels this indicates that the animals need to be supplemented with P. The Ca and P concentrations of pigeon pea in this study was greater than the Ca and lower than the P results reported by Adjolohoun *et al.,* (2008) that was 0.76 and 0.17% of DM, respectively. The variation in the concentrations of the macro minerals calcium (Ca) and phosphorus (p) of the sample feeds might be due to differences in plant genotype, soil environment, climate and stage of maturity at harvest (Suttle, 2010). Thus leads to the fact that leguminous species are generally much richer in macro minerals than grasses growing in a comparable conditions whether temperate or tropical areas (Minson, 1990). The concentrations of calcium (Ca) and phosphorus (P) in the concentrate mixture feed in this study were greater than the Ca content of rice bran reported by Adugna (2008) which was 0.1% and less than the Ca content of sesame seed cake reported by the same author was 0.77% of DM. In general the concentrate mixture (75% Rice Bran and 25% Sesame Seed Cake) used in this study was characterized as having low concentrations of calcium and phosphorus. According to Mogus (1992) and Adugna (2008), most oil seed cakes and milling byproducts are usually low in calcium and high in phosphorus contents.

3. Conclusion

The results of chemical analysis indicated that hay had 95.75%, 89.75% and 5.56% of CP, DM and OM respectively. In addition hay had higher contents of NDF, ADF and ADL which were 78.74, 53.90 and 14.53% of DM respectively; and characterized as low quality fibrous feed that can limit intake and digestibility of DM. The CP contents of *Tsara* (*Pterocarpus lucens*), Pigeon pea (*Cajanus cajan*) and concentrate mixture were 16.75, 20.61 and 21.80 respectively. And higher ADL content which was 14.53 and 13.49 % was observed in the hay and *Tsara* (*Pterocarpus lucens*) respectively. In addition, relatively higher contents of condensed tannin concentration were observed in *Tsara* (*Pterocarpus lucens*) and Pigeon pea (*Cajanus cajan*) which were 6.80 and 7.71 respectively than the CT concentrations of 1.87 and 0.75% DM for hay and concentrate mixture feeds respectively. Accordingly lower CT concentrations were obtained in hay and concentrate mixture whereas higher CT concentrations was available in the browse feeds. On the other hand, higher calcium (Ca) contents were recorded for *Tsara* (*Pterocarpus lucens*) than hay, Pigeon pea (*Cajanus cajan*) and concentrate mixture which was 1.81% DM and lower in hay, Pigeon pea (*Cajanus cajan*) and concentrate mixture which were 0.60, 0.86 and 0.62%DM respectively. Whereas the phosphorus (P) content of the dietary treatment feeds were relatively higher in concentrate mixture, *Tsara* (*Pterocarpus lucens*) and Pigeon pea (*Cajanus cajan*) than hay; which were 0.17, 0.15, 0.13 and 0.07% DM respectively.

In conclusion based on the chemical analysis result the browse feeds *Tsara* (*Pterocarpus lucens*) and Pigeon pea (*Cajanus cajan*) can be used as a supplemental feed resources in ruminant feeding to maintain continuous improvement in fertility and growth rate of animals throughout the year. Therefore, further animal response studies must be conducted in relation to feed intake, digestibility, growth rate and the anti nutritional effect of condensed tannin in these supplemental browse feeds.

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