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Review on Nutritional Quality of Indigenous Forages in Ethiopia

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Abstract: *Ethiopia is known with great diversity of indigenous forage grasses, legumes and browse species used as the primary sources of animal feeds across in all agro-ecology. This review aimed to review the nutritional value of identified indigenous forage species for livestock production. Nutrition is one of the major constraints to cattle production in the tropics, particularly the lack of protein during the dry season. Like Cenchrus ciliaris, Chrysopogon aucheri, Heteropogon contortus, Hyparrhenia rufa, Pennisetum polystachyon, Brachiaria humidicola, Cynodon dactylon (L. Pers.), etc are some of grass species identified in different areas of Ethiopia by different authors. Different indigenous herbaceous legumes were identified and of this Trifolium species are more dominates in grazing land than other legume species. Most browse species investigated showed relatively high fodder value due to high level of crude protein, metabolisable energy, and mineral. The fodder trees (shrubs and browse) species dominates in the parts of Ethiopia for livestock feed. CP contents of indigenous grasses ranged with the range of (6-8%) considered for the maintenance requirement and lower of the critical limit of lactation (12%) and growth (11.3%). The DM and fiber contents (NDF, ADF, and ADL) of grass species are higher than the maximum level of limit may exhibit voluntary DM intake and livestock production. IVDMD content of identified grass species are below the respective digestibility value. The nutrient contents indicate a high potential for using the herbaceous legume and foliage of some fodder tree species as a feedstuff, other constituents also need to be considered. Most fodder trees examined have adequate crude protein contents for animal production. Again, there is considerable variation between species. Mineral concentrations vary significantly between species, ranging from toxic to inadequate for livestock production. Most fodder tree tested had adequate Calcium levels, deficiencies in Phosphorus which is leading to an imbalance in the calcium to phosphorus ratio in foliage. Such differences may reflect differences in soil and growing conditions more than differences between species. Plant species, plant part, stage of maturity, climatic variables and management factors are factors affects forage quality. Oxalate and condensed tannins are anti nutritional factors in the forages. Therefore, indigenous forages were good feed resources for livestock utilized during feed gaps and drought season..*

Keywords: *Chemical composition; Crude protein; Fiber; Indigenous forage*

1. Introduction

Ethiopia is known with great diversity of forage grasses, legumes and browse species indigenous to the country. These biological resources are the primary sources of animal feeds which support the growth domestic product (GDP) of the country and the potential of the indigenous forage and pasture gene pool for improvement of the livestock feed. Nutrition is one of the major constraints to cattle production in the tropics, particularly the lack of protein during the dry season. Low quality and quantity of feed has long been identified as the most important problem constraining the livestock sector in Ethiopia. It is the prominent setbacks of the livestock sector in Ethiopia resulting in a low contribution of the sector for the nationwide gross domestic product which is in contrary to the large population of livestock species in the country. It is well known that forages have an important role in ruminant animal production in terms of providing energy, protein and minerals (Kamlak, 2010).

According to Adugna *et al*. (2012) feed resources can be classified into natural pasture, crop residue, improved pasture and forage and agro-industrial by-products of which the first two contribute the largest share. Natural pastures are naturally occurring grasses, legumes, herbs, shrubs and tree foliage (Adugna, 2008). Indigenous plant species is dominant and still contribute an indispensable source of feed for ruminant livestock across all agro-ecology of Ethiopia, the production capacity and quality of natural grazing lands has been deteriorating over time and could not support optimum livestock production.

This arises from overgrazing of the natural grazing lands as a result of poor grazing land management (Alemayehu, 2003; Getnet, 2003; Zewdie and Yoseph, 2014). Several studies have evaluated the native grass lands and reported that the potential and nutritional contents of indigenous plant species are different from one season to another season, and from one agro-ecology to another (Ayana and Oba, 2010; Diriba *et al*., 2012; Keba *et al.*, 2013).

Natural grazing lands are spatially and temporally heterogeneous (Eaton *et al*., 2011) and its

chemical composition varies with environmental factors viz; altitude, rainfall and soil type, cropping intensity, grazing land management and variation in the genetic characteristics inherent to specific individual plant species (Alemayehu, 2003; Teka *et al*., 2012). These factors also affect the forage yield, intake and digestibility and animal grazing behavior (Solomon and Teferi, 2010). Quality and palatability of herbaceous plants affects the amount of vegetation that is consumed, rates of animal body weight gains and reproductive success (Mario et al., 2013). Evaluating the nutritional value of forages is imperative in livestock nutrition, because effective livestock production is associated to the quantity of nutrients in the forage (Schut *et al*., 2010).

Total digestible nutrient (TDN), crude protein (CP) and metabolisable energy (ME) are often used as indicators of forage quality (Pinkerton, 2005). France *et al.,* (2000) noted that the nutritional value of forage depends on the amount of proteins and digestible carbohydrates. In addition, ash, lignin, cellulose, crude fiber, phosphorus carotene and some other plant chemical compounds are also measured as indicators of forage quality. El-Waziry (2007) considered the dry matter digestibility as the main index for determining forage quality. Belyea et al., (1993) and Van Soest (1991; 1994) showed that the acid detergent fiber (ADF) was a better indicator for determining the nutritional value compared to crude fiber, because ADF contain cellulose and lignin and the dry matter digestibility decreased with increasing lignin. Belyea et al. (1993) stated that nitrogen content and ADF are two important factors in determining the metabolisable energy requirements of livestock.

Different forage species exhibit variations in terms of their nutritional qualities. This could be due to inherent nature of the species, morphological and anatomical differences among grass species within the same agro-ecology. Species and agro-ecological differences are known to be the major factors in affecting the nutritive value of native forage species (Desalew, 2008; Teklu *et al.*, 2010; Mengistu *et al*., 2015). Teka *et al.* (2012) reported that variation in the nutritive value of herbaceous species might also be attributed to sites' potential in terms of differences in soil characteristics and temperature conditions that arise from agro-ecological differences.

Considering the large population of cattle and browsing animals in Ethiopia, on one hand and the acute shortage of conventional fodder feed resources on the other, one would suggest that there should be another supplementary feed resource, like the indigenous grass, herbaceous legume and browse which are easily accessible. These large populations of browse and graze animals must depend on the feed resource of their vicinity including the indigenous grasses, herbaceous legumes, and scattered tree and shrub species found all over the marginal grazing landscapes. Ethiopia where there is a rich diversity of native grass, herbaceous and woody flora with potential browse value. However, documentation the nutritional value of the indigenous forage species are great important. Therefore the objective of this paper is to review the nutritional value of identified indigenous forage species for livestock production in Ethiopia.

Overview of Identified Indigenous Forages in Ethiopia

Indigenous forage species a primary sources of feeds for livestock especially where extensive livestock production system in pastoral and agro-pastoral areas. Majority of these species are found in rangelands and communal grazing areas of the country. They can categorize in to grass, herbaceous legume, and fodder tree (browse) and shrubs species.

Indigenous Grass Species

Grass is a common word that generally describes a monocotyledonous green plant in the family Poaceae. Grass occupies a greater area of the world's surface than any other plant family, occurring in almost every terrestrial environment and provides a vital source of feed for animals (Cheplick, 1998).

Forage grasses can be either annuals or perennials with a wide spectrum of adaptation and diverse growth habits and thus they are distributed in all continents and climatic zones (Pamo and Piper, 2000).

Both annual and perennial grasses are herbaceous (non-woody) plants, made up of a grouping of units called tillers. Perennial grasses often live for relatively a few or several seasons by succession of secondary tillers, which replace the original tillers. However, annual grasses flower and die without producing replacement tillers which will be the reason for the death of the whole plant (Wolfson and Tainton, 2000).

In Ethiopia, particularly in the mid and lowland area, farmers used to feed their animals with natural and indigenous grasses such as Cenchrus, Cynodon, Themeda, Pennisetum, Entropogon, Bothriochloa, Brachiaria, Sporobolus, Panicum, Chloris, Aristida, Dactyloxenium, Leptothrium, Heteropagon and Hyparrhenia. Of the above mentioned indigenous grasses, Cenchrus ciliaris, Chrysopogon aucheri, Digitaria milanjiana, Eragrostis papposa, Panicum maximum, Heteropogon contortus and Aristida adoensis are common grass species in the semi-arid rangelands of Borana in southern Ethiopia (Coppock, 1994; Gemedo et al., 2006; Keba et al., 2013).

Diriba et al. (2012) reported Pennisetum polystachyon, Bracharia himidicola, Bidens prestinaria, Alectra sessilifora, Eragrostis viscosa, Eragrostis velwitschii, Hypherhennia rufa, Hypherhennia anamesa, Hypherhennia anthistirioides, Lipia adoensis, Sporobolus pyramidalis, Polygala persicalifolia are common herbaceous species under sub humid climatic conditions around Menasibu district of Western Ethiopia. Accordingly, three perennial grass species; Hyparrhenia rufa, Pennisetum polystachyon and Brachiaria humidicola, with respective percentage values of 28.57, 14.29 and 11.43 were observed to be dominant. Among the grass species, Brachiaria humidicola was the most preferred species by grazing livestock. It was also reported to perform fine on acid soils and resist termite attacks, the two important factors hindering productivity of native grasslands in the western Ethiopia. Also, According to Andualem Tonamo et al., (2015) reported ‘Lamuxxa’ grass was mostly used as cattle feed during dry season of the year/ feed shortage season in the Essera district of Walayita zone, southern Ethiopia. 'Lamuxxa' was one more feed resource in the Essera district and was naturally cultivated grass species in Kolla agro-ecology particularly on the mounted area of the district and used as feed by cut-carry system for principally milking cow.

The major native grass species were identified from the grazing lands of Horro and Guduru districts of western Ethiopia. Those grass species identified are: pennisetum clandestinum, Eragrostis tenuifolia, Cynodon dactaylon, Digitaria abyssinica, Andropogon abyssinicus, eulisine jaegeri, pennisetum sphacelatum, pennisetum thunbergii, and Sporobolus pyramidalis (Gurmessa et al., 2015). Urge et al. (2018) reported that fifteen major indigenous grass species such as Cenchrus ciliaris, Cynodon dactylon (L. Pers.), Sporobolus pyramidalis P. Beauv., Heteropogon contortus (L.) Roem. & Schult, Chrysopogon aucheri, Setaria barbata (Lam.) Kunth, Hyparrhenia hirta (L.) Stapf, Panicum maximum Jacq, Sorghum arundinaceum (Desv.) Stapf, Digitaria ternata (A. Rich.) Stapf, Sporobolus fesivalis, Leersia hexandraSw, Themeda triandra, Bothriochloa insculpta and Eragrostis papposa found in the all agro ecologies (Highland, midland and lowland) were identified and have wider adaptation in the Adola rede district of Guji zone area which was similar with the report of (Keba et al., 2014; Diriba et al., 2012; Gurmessa et al., 2015).

Table1. *Some of identified indigenous grass species in different areas of Ethiopia*

Local name	Botanical name	Family name	Authors
Serdoyta/Mata guddeesa	*Cenchrus ciliaris*	Poaceae	Asheber *et al.*, (2010); Abebe *et al.*, (2012); Keba *et al.*, (2013); Urge *et al.*, (2018); Abdulahi *et al.*, (2018)
Rareta/Qorcaa/ Chokorsa qala/Moth	*Cynodon dactylon (L. Pers.)*	Poaceae	Asheber *et al.*, (2010); Keba *et al.* (2013); Deribe, (2015); Gurmessa *et al.*, (2015); Gelaye , (2015); Urge *et al.*, (2018); Abdulahi *et al.*,(2018)
Miciica/Muriyyi/ Thoath	*Sporobolus pyramidalis P. Beauv.*	Poaceae	Diriba *et al.*, (2012); Gurmessa *et al.*, (2015); Gelaye , (2015); Urge *et al.*, (2018)
Qophii	*Heteropogon contortus (L.) Roem. & Schult*	Poaceae	Keba *et al.*, (2013); Abdulahi *et al.*,(2018); Urge *et al.*, (2018)
Allaloo	*Chrysopogon aucheri*	Poaceae	Abebe *et al.*, (2012); Keba *et al.*, (2013); Urge *et al.*, (2018)
Sokorru	*Setaria barbata (Lam.) Kunth*	Poaceae	Urge *et al.*, (2018)

Luuccole	*Hyparrhenia hirta (L.) Stapf*	poaceae	Urge *et al.*, (2018)
Gaw /Laabbessa	*Panicum maximum Jacq*	poaceae	Keba *et al.*, (2013); Gelaye , (2015); Urge *et al.*, (2018); Abdulahi *et al.*, (2018)
Obbaa	*Sorghum arundinaceum (Desv.) Stapf*	poaceae	Urge *et al.*, (2018)
Sutaa	*Digitaria ternata (A. Rich.) Stapf*	poaceae	Urge *et al.*, (2018); Abdulahi *et al.*,(2018)
Miciica lagaa	*Sporobolus fesivalis*	poaceae	Urge *et al.*, (2018)
Qabataa	*Leersia hexandra Sw*	poaceae	Urge *et al.*, (2018)
Saamphilee	*Themeda triandra*	poaceae	Keba *et al.*, (2013); Urge *et al.*, (2018)
Luuccole gammoojji	*Bothriochloa insculpta*	poaceae	Keba *et al.*, (2013); Urge *et al.*, (2018)
Qaawwaa	*Eragrostis papposa*	poaceae	Keba *et al.*, (2013); Urge *et al.*, (2018); Abdulahi *et al.*,(2018)
Dit	*Brachiaria semiundulata* (A. Rich.) Stapf.	poaceae	Gelaye , (2015)
Desho	Pennisetum pedicellatum	poaceae	Welle *et al.*, (2006)
Chumear	*Pennisetum polystachion* (L.) Schult.	Poaceae	Diriba *et al.*, (2012); Gelaye , (2015)
Chomo	*Brachiaria humidicola*	poaceae	Diriba *et al.*, (2012)
Daggo	*Eleusine floccifolia*	poaceae	Gurmessa *et al.*, (2015); Deribe, (2015)
Aganjira	*Eleusine africana*		Gurmessa *et al.*, (2015)
Daggala	*Hyperrhenia rufa*	poaceae	Gurmessa *et al.*, (2015); Diriba *et al.*, (2012); Abdulahi *et al.*,(2018)
Sardoo	*Pennisetum clandestinum*	poaceae	Gurmessa *et al.*, (2015)
Mujja	*Snowdenia polystachya*	poaceae	Gurmessa *et al.*, (2015)
Migra saree adii	*Penniseturn sphacelaturn*	poaceae	Gurmessa *et al.*, (2015)
Lamuxxaa'	-	poaceae	Andualem Tonamo *et al.*, (2015)
Xaafii sinbirroo	*Eragrostis tenuifolia*	poaceae	Gurmessa *et al.*, (2015)
Marga qalla	*Digitaria abyssinica*	poaceae	Gurmessa *et al.*, (2015)
Ballammi	*Andropogon abyssicus*	poaceae	Gurmessa *et al.*, (2015)
Warati	*Eleucine jagrie*	poaceae	Gurmessa *et al.*, (2015)
Guba (Migira)	*Pennisetum sphacelatum*	poaceae	Gurmessa *et al.*, (2015)
Migra saree diima	*Penniseturn thunbergi*	poaceae	Gurmessa *et al.*, (2015)
	Digitaria milanjiana	poaceae	Keba *et al.*, (2013)
	Digitaria naghellensis	poaceae	Keba *et al.*, (2013)
	Pennisetum mezianum	poaceae	Abebe *et al.*, (2012); Keba *et al.*, (2013)
	Dactyloctenium aegyptium	poaceae	Keba *et al.*, (2013); Abdulahi *et al.*, (2018)
	Setaria verticillata	poaceae	Keba *et al.*, (2013); Abdulahi *et al.*, (2018)
	Eleusine intermedia	poaceae	Keba *et al.*, (2013)
	Aristida adoensis	poaceae	Keba *et al.*, (2013); Abdulahi *et al.*, (2018)
Kut	*Echinochloa colona* (L.)Link.	Poaceae	Gelaye, (2015)
Bor	*Echinochloa pyramidalis* (Lam.) Hitchc. & Chase	poaceae	Gelaye, (2015)
Pon	*Oryza longistaminata* A. Chev. & Roehr	poaceae	Gelaye, (2015)
jualJoack	*Setaria pumila* (Poir.) Roem. & Schult	poaceae	Gelaye, (2015); Abdulahi *et al.*, (2018)
Hol	*Setaria 4ncrassate* (Hochst.) Hack.	Poaceae	Gelaye, (2015)
	Bothriochloa radicans	poaceae	Abdulahi *et al.*, (2018)
	Chrysopogon plumulosus	poaceae	Abdulahi *et al.*, (2018)
	Digitaria velutina (Forskk	poaceae	Abdulahi *et al.*, (2018)
Sardo harre	*Eleusine indica*	poaceae	Gurmessa *et al.*, (2015); Abdulahi *et al.*, (2018)
	Eragrostis cilianensis	Poaceae	Abdulahi *et al.*, (2018)
	Paspalidium desertorum (A.Rich)	Poaceae	Abdulahi *et al.*, (2018)

	Sporobolus panicoides(A.Rich)	Poaceae	Abdulahi *et al.*, (2018)
	Tragus barteronianus	Poaceae	Abdulahi *et al.*, (2018)
	Tragus racemosus	Poaceae	Abdulahi *et al.*, (2018)
	Urochloa panicoides	Poaceae	Abdulahi *et al.*, (2018)
No name	*Eragrostis paniciforms*	Poaceae	Gurmessa *et al.*, (2015)
No name	*Lolium multiflorum*	Poaceae	Gurmessa *et al.*, (2015)

Indigenous Herbaceous Legume Species

Natural pasture was first most important source of feed for their cattle in both dry and wet season in the Essera district of dawuro zone (Andualem Tonamo et al., 2015). Grazing on natural pasture was the most dominant feeding practice for cattle. Cattle are reared on natural pasture under continues grazing systems. Natural pasture in the high altitudes was rich in pasture species, particularly indigenous legumes (Kechero et al., 2010). Andualem Tonamo et al. (2015) reported in Essera district of Dawuro zone, Dawuro daama and Gasaa (Dawuregna) were mostly used as cattle feed during dry season of the year/ feed shortage season in the district.

Gurmessa et al. (2015) reported that legume species covers the grass land about 28.7 percent of herbage yield in highland and 25.6 percent in mid altitude of Horro and Guduru districts, western Ethiopia. The higher proportion of legumes observed conforms to the idea that the composition of legumes increase with the increase in altitude (Alemayehu, 2006). Horro and Guduru districts, during the wet season, grazing lands Wild trifolium species dominates with few legume species and contains a significant proportion of Trifolium species which is grazed prior to full blooming causing problem of bloating and subsequently death of animals. The higher percentage of trifolium species in highland could be due to hilly topography, large number of equines which have deep grazing habit and larger population density of livestock which selectively feed palatable species of grass land. In addition, Gezahagn et al., 2016 reported that the Native trifolium in Ethiopia includes Trifolium decorum, T. burchellianum, T. quartinianum, T. semipilosum and T. tembense. Crotalaria albicaulis, Indigofera viciodes and Tephrosia subtriflora are The indigenous legume species found in the rangeland of eastern Ethiopia (Abdulahi et al., 2018).

According to Gelaye, (2015) reported the native legume species such as Aeschynomene indica L., Desmodium uncinatum (Jacq.) DC., Indigofera arrecta Hochst. ex A.Rich., Rhynchosia stipulosa A. Rich., Senna obtusifolia (L.) Irwin & Barneby and Vigna membranacea A. Rich were identified and available in the Gambella range land of south western Ethiopia, of this identified legumes Desmodium uncinatum (Jacq.) DC., Senna obtusifolia (L.) Irwin & Barneby and Vigna membranacea A. Rich are desirable species to the areas.

Table2. *Some of identified indigenous herbaceous legume species in different areas of Ethiopia*

Local name	**Botanical name**	**Family name**	**Authors**
Siddisa dhalaa	*Trifolium rueppellianum*	Fabaceae	Diriba *et al.*, (2012); Gurmessa *et al.*, (2015)
Siddisa kormaa	*Medicago polymorpha*	Fabaceae	Gurmessa *et al.*, (2015)
Atara quruphe	*Vicia sativa L.var.sativa*	Fabaceae	Gurmessa *et al.*, (2015)
	Crotalaria albicaulis	Fabaceae	Abdulahi *et al.*, (2018)
	Indigofera viciodes	Fabaceae	Abdulahi *et al.*, (2018)
	Tephrosia subtriflora	Fabaceae	Abdulahi *et al.*, (2018)
'Dawuro daama'	-	-	Andualem Tonamo *et al.*, (2015)
'Gasaa'	-	-	Andualem Tonamo *et al.*, (2015)
Reir	*Senna obtusifolia* (L.) Irwin	Fabaceae	Gelaye, (2015)
Reim	*Vigna membranacea* A. Rich	Fabaceae	Gelaye, (2015)
	Trifolium decorum	Fabaceae	Gezahagn *et al.*, (2016)
	T. burchellianum	Fabaceae	Gezahagn *et al.*, (2016)
	T. quartinianum	Fabaceae	Gezahagn *et al.*, (2016)
	T. semipilosum	Fabaceae	Gezahagn *et al.*, (2016)
	T. tembense	Fabaceae	Gezahagn *et al.*, (2016)

Indigenous Fodder Tree (Browse) and Shrub Species

Most of indigenous browse species that are dominant in most parts of the Ethiopia have an important role to provide feed for livestock. Indigenous browse species contribute to a significant proportion of animal feed and agro-biodiversity in developing countries (Emiru et al., 2014). Attempts made to increase knowledge and exploitation of indigenous forage species have proved that indigenous browse species play significant role in animal production, primarily by providing animals with feed resources rich in protein, energy, vitamins and minerals at a time when feed is scarce or is of low quality (Bamikole et al., 2004; Salem et al., 2006). In addition to their value as sources of green fodder, most indigenous browse species are multipurpose and provide benefits and services such as food, fiber, shade, soil improvement and conservation, timber, fuel wood and live fences across all of the agro-ecological zones of Africa (Osakwe and Drochner, 2006).

Indigenous fodder tree (browse) and shrub species are critical feed resources for the pastoralist and agro-pastoralists in Ethiopia. Native tree fodders are important source of feeds in the areas dominated by small holder farmers in Ethiopia, and in many others of the globe (Derero and Kitaw, 2018). Many authors were identified different major indigenous fodder trees (browse) and shrubs species used as feeds for livestock located in various areas in Ethiopia. The favored fodder tree (browse) and shrub parts aids for feed are leaf, twinges and pod. The role of browse forages as nitrogen sources for ruminants, especially during lean periods, is the major contribution of the browses in many parts of the tropics where other nitrogen sources may not be readily available and/or are expensive (Osuga et al., 2006). Browse species can make a large contribution to livestock nutrition especially during the dry season when livestock almost wholly depend on such species (Belete et al., 2012). Lands dominated by woody species, namely shrub lands, savannas and forest ranges provide green forage for grazing animals throughout the year (evergreen species) or at specific critical periods of the year (deciduous species) (Kökten et al., 2012).

According to Belete et al., (2012) reported about 18 indigenous browse species as locally important were identified being used as feed sources by cattle, goats and sheep in mid rift valley areas of Ethiopia. Indigenous browse species remain green at the critical period of the year and make a good source of dry season feed for ruminants in arid and semi-arid agro-ecologies where annual grasses and other herbaceous plants fail to produce year round. Also, during the wet season, cattle and sheep are less attracted to the browse species because of the herbaceous component become more abundant and nutritious. However, during the dry season, the herbaceous components are less abundant and often become more fibrous. Therefore In dry season cattle and sheep depend first on leaves and succulent twigs of browse species. Out of indigenous browse species identified in the mid rift valley of Ethiopia are Acacia tortilis, Acacia mellifera, Ziziphus mucronata, Capparis fascicularis, Celtis africana, Grewia bicolor, Olea europaea, Dichrostachys cinerea, Balanites aegyptica were most favored by goats and they utilized by cattle and sheep (Belete et al., 2012).

The most widely utilized browse species in mid rift valley of Ethiopia were Acacia tortilis (95.8%), Balanites aegyptica (79.2%), Ficus gnaphalocarpa (77.5%), Olea europaea (77.3%), Grewia bicolour (75.0%) and Dichrostachys cinerea (70.0%) (Belete et al., 2012). Beyene, (2009) documented the common browse like Rhus natalensis, Bauhinia farea, Grewia ferruginea, Acacia seyal and Deinbollia kilimandscharica in the Gembella region of south western Ethiopia. Teferi (2006) also documented Ziziphus spina-christi, Acacia asak, Acacia lahai, Balanites aegyptiaca and Terminalia brownie as some of the most commonly utilized and distributed browses species in the Deberke district of northern Ethiopia.

Table3. *Some of identified indigenous fodder tree (browse) and shrubs species in different areas of Ethiopia*

Local name	Botanical name	Family name	Authors
Gessalto	A.nilotica	-	Derero and kitaw, (2018); Abebe *et al.*, (2012)
Ajjoo/ Deweni girar	A.tortilis	-	Derero and kitaw,(2018); Gebeyew *et al.*, (2015); Muluken *et al.*, (2015); Abebe *et al.*, (2012)
	B. discolor	-	Derero and kitaw, (2018)
	C. sinensis	-	Derero and kitaw, (2018)
	D. glabra	-	Derero and kitaw, (2018)

Koat	*Tamarindus indica*	Combretaceae	Derero and kitaw, (2018); Gelaye, (2018)
Giba/kurkura	*Z. spina-christi*	-	Derero and kitaw, (2018); Muluken *et al.*, (2015)
Merkaeto/ Sopheensa	*Acacia mellifera*	Memosoideae	Belete *et al.*, (2012); Emiru Birhane *et al.*, (2014); Welay *et al.*, (2018)
Garmoita	*Acacia oerfota*	-	Emiru Birhane *et al.*, (2014)
Dhooqonuu/ Midhengurre	*Grewia ferruginea*	Tiliaceae	Welay *et al.*, (2018); Ahmed *et al.*, (2017)
Ashedo	*Grewia tembensis*	Tiliaceae	Welay *et al.*, (2018); Ahmed *et al.*, (2017); Abebe *et al.*, (2012)
Dhakka	*Grewia tenax*	Tiliaceae	Welay *et al.*, (2018)
Doboobessa	*Rhus natalensis*	Anacardiaceae	Welay *et al.*, (2018); Abebe *et al.*, (2012); Blete *et al.*, (2012)
Qurqura	*Ziziphus mauritiana*	Rhamnaceae	Welay *et al.*, (2018)
	Celtics Africana	-	Belete *et al.*, (2012)
	Balanites aegyptica	-	Belete *et al.*, (2012); Abebe *et al.*, (2012); Gelaye, (2018)
	Capparis fascicularis	-	Belete *et al.*, (2012)
	Caucanthus auriculatus	-	Belete *et al.*, (2012)
'Cayshiyaa'	-	-	Andualem Tonamo *et al.*, (2015)
	Celtics Africana	Ulmaceae	Belete *et al.*, (2012)
	Cordia Africana	Boraginaceae	Belete *et al.*, (2012)
	Cordia ovalis	-	Belete *et al.*, (2012)
	Dichrostachys cinera	-	Belete *et al.*, (2012)
	Ficus gnaphalocarpa	Moraceae	Belete *et al.*, (2012)
	Grewia bicolor	-	Belete *et al.*, (2012); Abebe *et al.*, (2012)
	Maytenus arbutifolia	Celasteraceae	Belete *et al.*, (2012)
	Olea europaea	Oleacea	Belete *et al.*, (2012)
	Premna schimperi	-	Belete *et al.*, (2012)
	Pygeum africanum	-	Belete *et al.*, (2012)
	Zizphus mucronata	-	Belete *et al.*, (2012)
Waachuu	*Acacia seyal Del.*	-	Gelaye, (2018); Abebe *et al.*, (2012)
	Acacia senegal	-	Gelaye, (2018)
	Cadaba farinosa	-	Gelaye, (2018)
	Acacia brevispica	-	Abebe *et al.*, (2012)
	Vernonia cinerscens	Asteraceae	Abebe *et al.*, (2012)
	Maracaa	-	Abebe *et al.*, (2012)

In Afar rangelands of Awash fantale and Amibara districts 15 major indigenous browse species were identified as being used as animal feed resources by livestock reported by Merga, (2016). Similarly, Emiru Birhane et al., (2014) selected the three most browse species for each of the animal species according to the browsing time spent on each of the species were A. oerfota, Balanites aegyptiaca and A. mellifera for camels; A. mellifera, A. oerfota and A. etbaica for goats; and A. etbaica, Grewia ferruginea and G. tenax for sheep in Alaba'a district in the rangeland of Afar, northern Ethiopia. Similar browse species were reported by Welay et al., (2018) in Mieso district rangeland. In addition, Beche et al., (2016) reported the pastoralists' people surrounded Awash National Park use a variety of habitats and plant species for their livestock feed. They utilize the surrounding area in a grazing mechanism. Thirty nine (62.9%) useful plants were used for forage, being distributed in 21 families and 33 genera. More than half (61%) of forage species belong to Poaceae, Fabaceae, Acanthaceae, Solanaceae, Tiliaceae, Capparidaceae, Cucurbitaceae, Malvaceae and Moraceae. The most important livestock feeds were documented, including trees 17 (43%), shrubs 9 (23%), herb 10 (26%), climber 2 (5%), liana 1(2.5%) species (Table 4). This was comparable with plant biodiversity of Borana Pastoralists (Gemedo et al., 2005) and higher in species number of forages with other regions (Yineger et al., 2008). This indicated that the knowledge of the people on the forage plants and their uses vary from lowland to highland. In the lowland area, pastoralists' life depends on livestock production that utilized more forage species than sedentary agro- pastoralists.

Some forage plants, such as Rostraria cristata, Solanum campylacanthum and Polypogon viridis were highly utilized plants for livestock feed. Rostraria cristata was perceived as the best grass that tended to increase milk production and it was also the most available grass type (Beche et al., 2016).

Table4: *List of forage plants utilized by the pastoralists in Ethiopia*

Scientific name and Specimen No.	Used for	Parts used	Utilization
Acacia negrii	Goat, cattle	Fruits	Directly feeding matured fruits
Delonix elata	Camel, goat, cow	Leaves	Directly browsing
Acacia etbaica	Cow, goat	Leaves, fruits, stem	Directly browsing
Balanites aegyptiaca	Camel, goat, cow	Leaves, fruits	Directly browsing/prepared for hay
Withania somnifera	Cow, goat	Leaves	Directly grazing
Sida ovate	Almost all	Leaves, fruits	Directly grazing
Grewia sp.	Cow	Fruits	Directly browsing
Grewia villosa	Cow	Leaves	Directly browsing/prepared for hay
Neuracanthus polyacanthus	Cow, goat	Leaves, fruits	Directly browsing/prepared for hay
Barleria proxima	Camel, goat	Leaves	Directly grazing/ prepared for hay
Sida collina	Cow, goat	Leaves, fruits	Directly grazing/ prepared for hay
Cucumis ficifolius	Camel, goat	Leaves	Directly browsing prepared for hay
Capparis tomentosa	Camel	Fruits, leaves	Directly browsing
Cadaba rotundifolia	Cow	Leaves	Directly browsing
Cucurbita feotid	Goat	Leaves	Directly browsing
Solanum incanum	Goat	Leaves	Directly browsing
Solanum tettense	Almost all	Leaves	Directly grazing
Lawsonia inermis	Cow	Leaves	Directly grazing
Berchemia discolor	Goat	Leaves, fruits	Directly grazing
Polypogon viridis	Cow, camel	Leaves, fruits	Directly grazing/prepared for hay
Combretum aculeatum	Goat	Leaves	Directly browsing
Solanum campylacanthum	Goat	Leaves, fruits	Directly browsing
Ziziphus spina-christi	Camel, goat	Fruits	Directly browsing
Acacia asak	Camel, goat	Leaves, fruits	Directly browsing
Boswellia microphylla	Cow, goat	Leaves	Directly browsing
Ficus capreaefolia	Almost all	Leaves, fruits	Directly browsing and as hay
Apodytes dimidiate	Camel	Leaves	Directly browsing
Rostraria cristata	Cow, camel	Stem, leaves	Directly grazing/prepared for hay
Celtis africana	Almost all	Fruits, leaves	Directly browsing
Lantana trifolia	Goat, camel	Fruits	Directly browsing and as hay
Bersama abyssinica	Goat	Leaves	Directly grazing and as hay
Fagonia schweinfurthi	Goat, camel	Leaves	Directly grazing and as hay
Ficus sycomorus	Almost all	Leaves, fruits	Directly browsing and as hay
Oxygonum sinuatum	Almost all	Leaves and stem	Directly grazing
Tamarindus indica	Camel, goat	Leaves, fruits	Directly browsing and as hay
Acacia senegal	Almost for all	Leaves, fruits	Directly browsing
Ximenia americana	Camel	Fruits	Directly browsing
Acacia oerfota	Almost for all	Leaves, fruits	Directly browsing
Peristrophe paniculata	Camel, Goat	Leaves, fruits	Grazing

(Source: Extracted from Beche et al., 2016)

Nutritional Quality of Indigenous Forages in Ethiopia

Chemical Composition of Indigenous Grass Species

The nutritional quality of identified major indigenous grass species in different areas of Ethiopia have been documented by different authors (Table 5). There are variations in the chemical composition values reported for grass species between season, species and site/location reported by (Gelaye, 2015; Abebe et al., 2012; Urge et al., 2018). The dry matter content of identified indigenous grass species in Adola reedde district of Guji zone, southern Ethiopia ranged from 90.75 % for Cynodon dactylon (L. Pers.) to 95.7 % for Heteropogon contortus (L.) Roem. & Schult (Urge et al., 2018) which was above the critical range of 70-80% which may limit the feed intake the livestock (Van Soest, 1994). This is in agreement with the report of Gelaye, (2015) that indicated the value of DM content of grass species of Gambella rangelands to be ranged from 89.65 % in Setaria incrassata (Hochst.) Hack. to 93.19% in Oryza longistaminata A. Chev. & Roehr , but higher than the report of Andualem Tonamo et al., (2015) indicated DM content of grass species of Essera district of Dawuro Zone of southern Ethiopia to be 62.63 % for 'Lumuxxa' grass and Bimrew et al., (2017) indicated 30.16 % of DM for Desho grass. This results of different authors showed that there were variation between species and locations.

The overall mean CP contents of herbage studied in Horro and Guduru districts of western Ethiopia was 11.75 % (Gurmessa et al., 2015). This result is comparable with (12.1 %) CP of forage harvested (Zinash and Seyoum, 1991) and below 13.1 % reported for Sinana district harvested in September (Solomon , 2008) and higher than previously reported CP value of 5.03- 8.07 for natural pasture harvested in Menasibu districts of western Ethiopia (Diriba et al., 2012). The reported mean CP of herbage falls within the normal threshold of grasses (8-18 %) and it was reported that forages with CP content of below 8 % are categorized under poor/low quality forages (Leng, 1990) resulting in less feed intake, less digestibility and poor utilization of feed. Similarly, Adugna and Said (1994) have pointed out that CP contents less than 7.5% inhibit intake, digestibility and proper utilization of feed DM. The CP content of different indigenous grass species evaluated in Adola reedde district of Guji zone were ranged within the recommended range (6 to 8%) considered adequate for maintenance requirements of most wild and domestic herbivores (Hussain and Durrani, 2009; Keba et al., 2013), but lower than the critical limit of 10.6% proposed by Minson (1990). McDonald et al. (2002) and Sampaio et al., (2009) also suggested that the minimum required level of CP content of grass species for optimal rumen functioning and microbial activity is 7-8%. Gelaye, (2015) indicated that the mean CP content of different grass species in the rangeland of Gambella was ranged from 7.82 % in Oryza longistaminata A. Chev. & Roehr to 13.39 % in Cynodon dactylon (L. Pers.) which is comparable with the report of Deribe (2018) that indicated the mean value of CP content of grass species 6.29 % in Eleusine floccifolia to 13.6 % in Cynodon dactylon (L. Pers.) in zones of Wolayita, Dawuro, Hadiya and Gurage that are located in the central parts of Southern Ethiopia. The result of CP of grass species in different areas of Ethiopia is in agreement with report of Paul et al. (2006) that suggested the CP content of tropical grass species to be in a range of 4-15.1%.

The ash content of grass species in semi arid areas of Borana range land was recorded from 12.8 % to 16.7 % (Keba et al., 2013). This report is in agreement with reports of Gurmessa et al., (2015) indicated that ash content of herbage in Horro and Guduru districts ranged between 9.21 % to16.9 %. Also, the ash content of grass species in Dawuro zone of southern Ethiopia was 7.95 % in 'Lumuxxa' grass by Andualem Tonamo et al., (2015), was lower than the reports of (Keba et al., 2013; Gelaye, 2015; Abebe et al., 2012; Teka et al., 2012; Urge et al., 2018) and in line with the finding of Paul et al. (2006) that ranges from 6.5-14%.

The NDF content of the grass species in Borana rangeland varied from 62.1 % in C. ciliaris to 68.3 % in P. mezianum by Abebe et al., (2012). This NDF content report is comparable in agreement with the report of (Keba et al., 2013; Deribe et al., 2015; Urge et al., 2018; Gelaye, 2015). This is also in agreement with Diriba et al. (2012) noted mean NDF value of 76% for grass species that exceeds threshold level and suggested that they exhibit lowest voluntary feed intake. The lower NDF content of grass species in Essera district was 41.92 % reported by Andualem Tonamo et al., (2015) which is comparably good quality. The NDF value beyond a threshold level (60%) that decreases voluntary feed intake increased rumination time and decreased efficiency of conversion of metabolizable energy to net energy. Therefore, herbage quality attributes as a whole indicate that the studied grasslands in the country are poor in supplying herbage of required quality suggesting the need for protein and energy supplementation to enhance the performance of animals grazing these pastures.

Acid detergent fiber (ADF) contents of grass species ranged from 25.30 %-54.95 % (Gelaye, 2015) in rangelands of Gambella, 40.4 to 61.8 % in the semi arid areas of Borana rangelands (Keba et al., 2013). This results in line with the reports of (Abebe et al., 2012; Urge et al., 2018; Deribe, 2015; Bimrew et al., 2017; Teka et al., 2012) and higher than report of Andualem Tonamo et al., (2015) indicated that ADF content of grass species was 23.43%. ADL content of grass species in adola Reedde district ranged from 9.3 % in Cynodon dactylon (L. Pers.) to 14.2 % in Heteropogon contortus (L.) Roem. & Schult by Urge et al., (2018). Also the Urge et al., (2018) finding is in contrast with the report of Andualem Tonamo et al., (2015) indicated that the ADL content of grass species in Essera district was 2.53% in ‘Lamuxxa' grass species.

Lignin is completely indigestible and forms lignin-cellulose/hemicelluloses complexes (Kellems and Church, 1998) due to physical encrustation of the plant fiber and making it unavailable to microbial enzymes (McDonald et al., 1995). The lignin contents of grass species reported by Urge et al., (2018) were higher than the maximum level of 7% that limits DM intake and livestock production (Reed et al., 1986).

The mean in vitro dry matter digestibility value ranged 42.67- 46.79 % obtained from grass species in Adola Reedde district of southern Ethiopia (Urge et al., 2018) was comparable with the reports of Diriba et al. (2012) and lower than the values reported by Deribe et al. (2013). This difference could be a result of wide variations in topography, elevation, rainfall distribution, soil fertility, management conditions and probable differences in the maturity stage of grass species. As cited by Diriba et al., (2012), Leng (1990), and Adugna and Said (1994) have indicated that forages with respective CP, and digestibility values lower than 8 and 55 % are categorized under low quality forages and as a result they exhibit low intake, digestibility and poor utilization of feed dry matter. Therefore, in terms of Crude Protein and digestibility values, indigenous grass species evaluated in the different areas of Ethiopia falls under the category of lowqualityforages.

Table5. *Nutritive value of some indigenous grass species in Ethiopia*

Local name	**Botanical name**	**Chemical composition (% DM)**							**IVDMD**	**ME (MJ)**	**Authors**
		DM	**OM**	**Ash**	**CP**	**NDF**	**ADF**	**ADL**			
Serdoyta/Mata guddeesa	*Cenchrus ciliaris*	-	-	12.8	7.24	67.36	50.4	-	81.15		Abebe et al., (2012)
		93.25		11.4	6.9	66.86	45.7	11.35	43.4	6.51	Urge *et al.,* (2018)
Rareta/Qorcaa/ Chokorsa qala/Moth	*Cynodon dactylon (L. Pers.)*	-	-	11.30 - 16.20	7.0 - 11.18	73.30 - 77.50	40.0 - 46.6	-	-	-	Keba *et al.,* (2013)
		-	-	-	13.6	64.33	37.84	-	68.14	-	Deribe, (2015)
		-	-	14.97	11.67	71.33	42.38	-	-	-	Teka *et al.,* (2012)
		92.22	87.64	14.41	13.39	74.02	35.23	-	-	-	Gelaye, (2015)
		90.75	-	9.15	9.75	61.9	41.25	9.3	50.4	7.56	Urge *et al.,* (2018)
Miciica/Muriyyi/ Thoath	*Sporobolus pyramidalis P. Beauv.*	94.3	-	12.24	6.5	68.85	47.3	12.5	42.3	6.35	Urge *et al.,* (2018)
Qophii	*Heteropogon contortus*	95.7	-	13.2	5.65	70.14	49.25	14.2	40.3	6.05	Urge *et al.,* (2018)

	(L.) Roem. & Schult										
Allaloo	*Chrysopogon aucheri*	-	-	12.6	8.24	70.99	55.52	-	71.5	-	Abebe *et al.,* (2012)
		93.45	-	11.45	6.9	66.9	45.8	11.4	43.4	6.51	Urge *et al.,* (2018)
Sokorru	*Setaria barbata (Lam.) Kunth*	94.7	-	12.65	6.3	69.45	47.8	12.9	41.95	6.26	Urge *et al.,* (2018)
Luuccole	*Hyparrhenia hirta (L.) Stapf*	94.8	-	12.6	6.25	64.45	47.7	12.9	41.95	6.29	Urge *et al.,* (2018)
Gaw /Laabbessa	*Panicum maximum Jacq*	94.05	-	12.2	6.5	68.38	47	12.3	42.3	6.35	Urge *et al.,* (2018)
		91.34	82.54	15.14	9.49	75.17	46.85	-	-	-	Gelaye, (2015)
Obbaa	*Sorghum arundinaceum (Desv.) Stapf*	93.8	-	12.05	6.6	68.2	46.75	12.1	42.65	6.4	Urge *et al.,* (2018)
Sutaa	*Digitaria ternata (A. Rich.) Stapf*	94	-	12.15	6.5	68.75	47	12.45	42.4	6.36	Urge *et al.,* (2018)
Miciica lagaa	*Sporobolus fesivalis*	94.45	-	12.5	6.3	69.2	47.7	12.85	42.1	6.32	Urge *et al.,* (2018)
Qabataa	*Leersia hexandra Sw*	93.9	-	12.15	6.55	68.4	47.15	12.34	42.4	6.32	Urge *et al.,* (2018)
saamphilee	*Themeda triandra*	94.4	-	12.3	6.4	69.01	47.7	12.65	42.2	6.33	Urge *et al.,* (2018)
Luuccole gammoojji	*Bothriochloa insculpta*	94.9	-	12.7	6.1	69.68	48.3	13.25	41.95	6.29	Urge *et al.,* (2018)
Qaawwaa	*Eragrostis papposa*	93.65	-	11.8	6.8	67.68	46.4	11.8	42.75	6.41	Urge *et al.,* (2018)
Desho Daggo	Pennisetum pedicellatum *Eleusine floccifolia*	30.16 -	89.78 -	-	7.86 6.29	74.81 87.66	42.51 53.39	5.37 -	43.94 31.7	6.18 -	Bimrew *et al.,* (2017) Deribe, (2015)
'Lamuxxa'		69.63	-	7.95	10.3	41.92	23.43	2.53	76.19	-	Andualem Tonamo *et al.,* (2015)
	Pennisetum mezianum	-	-	12.05	5.79	70.51	57.3	-	69.82		Abebe *et al.,* (2012)
	Setaria verticillata	-	-	14.25	9.57	68.00	43.93	-	-	-	Teka *et al.,* (2012)
Pon	*Oryza longistaminata* A. Chev. & Roehr	93.19	85.5	10.78	7.82	49.59	36.84	-	-	-	Gelaye, (2015)

Hol	*Setaria incrassata* (Hochst.) Hack.	89.65	89.23	10.78	8.13	78.78	51.54	-	-	-	Gelaye, (2015)

Chemical Composition of Indigenous Herbaceous Legumes Species

The chemical composition and in vitro dry matter digestibility of many indigenous legume species in Ethiopia were not evaluated individually rather than combination form as herbage. Dawuro daama and Gasaa was most indigenous herbaceous legumes found in central southern Ethiopia (Andualem Tonamo et al., 2015). The CP contents of Dawuro daama and Gasaa legume species was 14.23 and 12.35 %, respectively and is higher than the minimum threshold level of between 7% and 8 % CP required for optimum rumen function and feed intake in ruminant livestock.

Plant fiber has three major components: lignin, cellulose and hemi cellulose. Roughage feeds with NDF content of less than 45% are categorized as high quality, 45-65% as medium quality and those with more than 65% as low quality roughages (Singh and Oosting, 1992). The higher NDF content could be a limiting factor on feed intake, since voluntary feed intake and NDF content are negatively correlated (Ensminger et al., 1990). The NDF content of Dawuro daama and Gasaa species were 16.57 % and 9.43 % respectively. Also the ADF content of Gasaa species (10.53 %) was lower than the Dawuro daama species (5.34 %). Generally the chemical composition of indigenous legume species (Dauro daama and Gasaa) were found in southern Ethiopia could be classified as high quality feeds, which could not impose limitations on feed intake and animal production (Andualem Tonamo et al., 2015).

In addition, Andualem Tonamo et al., (2015) reported the in vitro dry matter digestibility contents of indigenous legume types were higher than the grass. Therefore, the highest content of IVDMD was found in Gasaa (95.29 %) followed by Dawuro daama (85.18 %).

Table6. *Chemical composition of identified indigenous legume species in Essera district of Dawuro zone*

Local name	Chemical composition (% DM)						IVDMD	Authors
	DM %	Ash	CP	NDF	ADF	ADL		
'Dawuro daama'	43.38	3.71	14.23	16.57	10.53	5.63	85.18	Andualem Tonamo *et al.*, (2015)
'Gasaa'	15.73	2.75	12.35	9.43	5.34	1.02	95.29	

Chemical Composition of Indigenous Fodder Tree (Browse) and Shrubs Species

The chemical composition and in vitro dry matter digestibility (IVDMD) of different fodder trees (browse) and shrubs species in the different areas of Ethiopia were presented in Table 5. Browse species are rich in CP, minerals and digestible nutrients than grasses (Devendra, 1990). High variability in the nutrient content of browse species is often encountered (Mohammed, 2009; Abebe et al., 2012).

Derero and kitaw, (2018) reported the dry matter content of fodder tree (browse) and shrubs species in pastoral and agro pastoral areas of Eastern Ethiopia varied from 90.9 % for C. sinensis and D. glabra to 93.53 % for A. nilotica which was above the critical range of 70-80 % which may limit the feed intake the livestock (Van Soest, 1994). Similarly, Belete et al., (2012) reported between species variation the DM content of different fodder tree (browse) species in mid rift valley of Ethiopia ranged from 87.4 % (Balanites aegyptica) to 93.2 % (Capparis fascicularis) and in line with those reported by (Muluken et al., 2015; Gelaye, 2018; Welay et al., 2018) in various areas of Ethiopia, but the value of dry matter content was reported by Emiru Birhane et al., (2014) varied from 30.39 – 52.26 % in Afar range lands of Northern Ethiopia was slightly lower than the report by Belete et al., (2012) but in line with Andualem Tonamo et al., 2015 in Essera district, southern Ethiopia.

Derero and kitaw, (2018) reported the organic matter of browse species analyzed in eastern Ethiopia varied from 93.32 % for T. indica to 97.14 % for A. nilotica and the ash content was ranged from 2.86 – 6.68 % which was lower than the ash content other browse species reported by (Belete et al., 2012; Gelaye, 2018) ranged between 6.9 for Dichrostachys cinera to 22 % for Cordia ovalis and 9.75 for T. indica to 16.29 % for Cadaba farinosa respectively. This variation is attributed to the differences in species and genotype, maturity of the browses, part of the plant included in the analysis, soil type, climate factors such as temperature and rain fall and methods of processing for chemical analysis of the samples (Gemedo et al.,2005).

The CP content of browse was high as compared to grass. Most browse species have the ability to maintain their greenness and nutritive value through the dry season when grasses dry up and deteriorate both in quality and quantity (Tolera et al., 1997). The CP content of different fodder tree species reported in the rangeland of Mieso of eastern Ethiopia by Welay et al., (2018) ranged from 15.5 for R.natalensis to 19 % for G.ferruginea which is lower than Mohammed reports in Chifra district of Afar regional state, Ethiopia for Grewia tembensis (22%); Gelaye reports in Gambella rangelands of southwestern Ethiopia for Acacia Senegal (29.03 %) and Cadaba farinose 28.42 %); Emiru Birhane et al., 2014 reports in Afar range land for Acacia oerfota (23.12 %) but higher than Belete et al., 2012; Derero and Kitaw, 2018 findings for other browse plant species. Abebe et al. (2012) reported the CP contents of the browse leaves from Borana rangeland ranged from 10.9 to 21 % in dry season. Browse leaves such as Acacia species in the tropics had a medium to high content of CP (range from 12 to 29.2 %, making them a valuable source of protein for livestock in the tropics (Abdulrazak et al., 2005). In general, leaves are higher in CP than twigs, almost twice in the case of Africa browses. However crude protein content of most fodder tree (browse) and shrub species in Ethiopia was within the range reported by Dicko and Sikena (1992) for different browse species with the range of 6 to 23% CP on DM basis. Variation in nutrient content of browse species is may be because of soil fertility difference and inherent ability of the plant to accumulate nutrients from the soil, and due to differences in protein accumulation in them during growth (Salem et al., 2006).

The CP contents of these indigenous fodder trees (browses) and shrubs in Ethiopia presented in (Table 7) were higher than the minimum of 7- 8% necessary to provide the minimum ammonia levels required by rumen microorganisms to support optimum rumen activity and required to satisfy the ruminal micro-organism of sheep and goats (Norton, 2003). Except some browse and shrub species like Dichrostachys cinera (9.8 %), Ficus gnaphalocarpa (10.8 %), Olea europaea (8.9 %) and Pygeum africanum (8.9 %) reported by Belete et al., (2012), the CP values of the identified species were also above the requirement for lactation (12 % CP) and growth (11.3 % CP) in the diets of ruminants as reported by ARC (1984) and it also in line with browse species from North Ethiopia (Yayneshet et al., 2009; Melaku et al., 2010) as well as Borana rangeland of South Ethiopia (Abebe et al ., 2012). The role of browse forages as protein supplement for ruminants especially during dry season is the major contribution of the browses in tropical and sub tropical regions where other nitrogen sources are not readily available or are expensive. This indicates the selected browse plants analyzed in Ethiopia may be well used as a protein supplement to low quality feeds such as crop residues due to a higher level of crude protein of all the browse plant species.

NDF contents for the indigenous forage tree (browse) species in Borana range land reported by Abebe et al., (2012) was ranged from 12.31 % (Acacia nilotica) to 75.09 % (Grewia tembensis) and is lower than the values reported by Larbi et al., (1998), Merkel et al., (1999) and Gemedo (2004) except for G. tembensis. In Gambella rangeland, NDF contents of the indigenous forage tree species ranged from 43.22 % for T.indica to 53.92 % for Cadaba farinose reported by Gelaye, (2018) and it is in line with the reports of (Derero and Kitaw, (2018); muluken et al., (2015); Ahmed et al., 2017). In mid rift valley of Ethiopia, NDF contents of the indigenous forage tree species ranged from 30.3 % for Celtics Africana to 78.5 % for Arundinaria alpine reported by Belete et al., (2012), in Chilga districts of North Gondar the NDF of the major browse species ranged between 32.53 % from Helinus mystacium to 85.45 % from Lecaniodicus fraxinifolius reported by Kassahun et al., (2016). Therefore higher NDF contents were in some browse species of Grewia tembensis, Lecaniodicus fraxinifolius and Arundinaria alpine whereas Acacia nilotica was the browse species records the lower NDF contents (Table 7). This is a positive attribute of the forages as they are the major energy sources for domestic livestock and wild lives in the rangelands. The variation in the NDF composition of the forages is an indication of variability in species, genotype, soil, climate and the growth phonology of the forages. Browse species with high NDF content like Grewia tembensis, Lecaniodicus fraxinifolius and Arundinaria alpine may impose a limitation on feed intake of grazing animals. Similarly NDF is the major determinant of overall forage quality and digestibility, and has direct effect on animal performance (Linn, 2004). Voluntary DM intake and DM digestibility are dependent on the cell wall constituents (fiber components) of the forages (Bakashi and Wadhwa, 2004). Except few browse species identified in Ethiopia, the many species of the NDF contents was below 50% and was lower than the concentration suggested as a limit which could affect intake and digestibility in ruminants (60-65%) reported in literatures (Van Soest et al., 1991).

According to Welay et al., (2018) reported Acacia mellifera (25.3 %) and ziziphus mauritania (24.8 %) had lower ADF percentage than Grewia ferruginea (30.7 %) and Grewia tenax (30.2 %) in Mieso rangeland. Also ADF were reported by Belete et al., (2012) in mid rift valley of Ethiopia ranged from 19.4-49.5%, with the highest being recorded in Cordia africana while the lowest value was recorded in Acacia mellifera. Another reported by Derero and Kitaw, (2018) the ADF varied from 26.58 % for Acacia tortilis to 38.18 % for Z. spina-christi and fall within the reported range for some fodder trees (Khanal and Subba, 2001), lower to comparable with figures reported for forage species (Mokonnen et al., 2009). It was comparable to higher than the reported figures for some tree fodders and browse species (Njidda et al., 2013). Lower values of ADF in leaves of browse species indicate good potential as ruminant feed (Bakshi and Wadhwa, 2007). In addition Derero and Kitaw reports the ADL, the leaves of D. glabra were the least lignified and those of Acacia nilotica were the most lignified. The Acid Detergent Lignin contents reported by Derero and Kitaw, (2018) in pastoral and agro-pastoral areas of eastern Ethiopia higher than the reports of Muluken, (2015) in major indigenous fodder trees and shrubs in Northeastern dry lands of Ethiopia.

The in vitro dry matter digestibility (IVDMD) of browse species was affected by species but unaffected by season and remained high both the dry and main rain season (Abebe et al., (2012). In addition, Abebe et al., (2012) reported IVDMD of indigenous fodder tree (shrubs and browse) species was ranged from 97.4 % (Acacia nilotica,) to the lowest values of 67.63% were recorded for Grewia bicolor in Borana rangeland. Also the IVDMD of various browse species in pastoral and agro-pastoral areas of eastern Ethiopia tested by Derero and kitaw, (2018) indicated that A. tortilis had the most digestible OM in the DM while C. sinensis had the least digestibility in the leaves compared to other tree and shrub species (Table 5). The IVDMD of browse species in the rift valley of Ethiopia reported by Ahmed et al., (2017) were 62.3 % for Grewia ferrugia, 62.6 % for Rhus natalensis and 65.4 % for Grewia tembensis lower than the reports of (Abebe et al., 2012; Derero and kitaw, 2018).

Table7. *Nutritive value of identified indigenous fodder trees (browse) and shrub species in Ethiopia*

Local name	**Botanical name of the species**	**Chemical composition (% DM)**							**IVDMD**	**Authors**
		DM	**OM**	**Ash**	**CP**	**NDF**	**ADF**	**ADL**		
Gessalto	A.nilotica	93.53	97.14	2.86	15.76	34.21	28.47	11.07	62.2	Derero and kitaw, (2018)
		-	-	4.25	15.43	12.31	8.47	-	97.47	Abebe *et al.*, (2012)
Ajjoo/ Deweni girar	A.tortilis	92.02	94.37	5.65	15.29	33.84	26.58	10.82	68.67	Derero and kitaw, (2018)
		85	-	4.1	14.1	19.5	16.9	4.2	-	Gebeyew *et al.*, (2015)
		92.6	92.2	7.78	19.5	45.3	25.2	5.02	-	Muluken *et al.*, (2015)
		-	-	6.23	17.78	21.76	15.47	-	88.69	Abebe *et al.*, (2012)
		-	-	-	11.74-20.12	30.2-45.11	33.54-33.66	-	-	Gemedo, (2004)
	B. discolor	93.04	95.77	4.23	18.19	32.99	28.78	10.21	64.75	Derero and kitaw, (2018)

	C. sinensis	90.89	93.52	6.48	15.93	63.09	37.95	7.82	51.14	Derero and kitaw, (2018)
	D. glabra	90.88	93.89	6.11	11.64	63.52	37.13	7.23	55.59	Derero and kitaw, (2018)
Koat	*Tamarindus indica*	92.2	93.32	6.68	15.93	32.9	27.97	10.11	66.96	Derero and kitaw, (2018)
		92.6	92.17	9.75	16.75	43.22	30.18	-	-	Gelaye, (2018)
Giba/kurkura	*Z. spina-christi*	90.63	94.1	5.9	16.27	63.65	38.18	7.49	55.04	Derero and kitaw, (2018)
		92.9	89.16	10.9	19.6	44.8	22.3	4.15	-	Muluken *et al.*, (2015)
Merkaeto/ Sopheensa	*Acacia mellifera*	91.2	-	12.6	12.6	33.7	19.4	8.86	-	Belete *et al.*, (2012)
		52.26	-	-	11.56	-	17.2	-	-	Emiru Birhane *et al.*, (2014)
		91.6	-	10	17	40.8	25.3	7.8	-	Welay *et al.*, (2018)

Local name	Botanical name of the species	Chemical composition (% DM)							IVDMD	Authors
		DM	OM	Ash	CP	NDF	ADF	ADL		
Garmoita	*Acacia oerfota*	30.39	-	-	23.12	-	21.22	-	-	Emiru Birhane *et al.*, (2014)
Dhooqonuu/ Midhengurre	*Grewia ferruginea*	93.3	-	10	19	46.8	30.7	9.5	-	Welay *et al.*, (2018)
		-	-	11.2	10.3	44.9	36.2	16	62.3	Ahmed *et al.*, (2017)
Ashedo	*Grewia tembensis*	92.7	-	10.1	18.2	47.3	28.2	8.5	-	Welay *et al.*, (2018)
		-	-	9.55	19.1	39.1	24.9	12.3	65.4	Ahmed *et al.*, (2017)
		-	-	11.48	19.56	75.09	28.11	-	88.93	Abebe *et al.*, (2012)
		-	-	-	17.87 - 18.65	29.32 -49.9	25.04 - 27.96	-	-	Gemedo, (2004)
Dhakka	*Grewia tenax*	92.6	-	10	18.7	46.8	30.2	9.2	-	Welay *et al.*, (2018)
Doboobessa	*Rhus natalensis*	94	-	9.5	15.5	65	42.4	10.6	-	Welay *et al.*, (2018)
		-	-	8.84	14.6	45.9	28.3	12.6	62.6	Ahmed *et al.*, (2017)
		-	-	7.77	13.41	46.03	31.2	-	82.51	Abebe *et al.*, (2012)

		-	-	-	12.08 - 13.19	28.37 -59.6	23.96 - 38.33	-	-	Gemedo, (2004)
Qurqura	*Ziziphus mauritiana*	93.1	-	10.1	18.1	46.4	24.8	6.9	-	Welay *et al.*, (2018)
	Celtics Africana	92.5	-	13.3	12.6	78.5	47.5	9.5	-	Belete *et al.*, (2012)
	Balanites aegyptica	87.4		21.2	15.2	44.6	33.8	11.1	-	Belete *et al.*, (2012)
		-	-	11.23	16.06	45.98	25	-	84.62	Abebe *et al.*, (2012)
		92.85	89.05	14.67	19.92	49.15	29.96	-	-	Gelaye, (2018)

Local name	**Botanical name of the species**	**Chemical composition (% DM)**							**IVDMD**	**Authors**
		DM	**OM**	**Ash**	**CP**	**NDF**	**ADF**	**ADL**		
		-	-	-	14.21 - 20.99	36.21 - 46.02	29.87 - 30.35	-	-	Gemedo, (2004)
	Capparis fascicularis	93.2	-	10.7	14.7	59.8	42.3	10.9	-	Belete *et al.*, (2012)
	Caucanthus auriculatus	90.9	-	11.8	14.6	41.6	33.8	12.4	-	Belete *et al.*, (2012)
'Cayshiyaa'	-	57.08	-	5	13.39	25.37	15.55	4.69	77.22	Andualem Tonamo *et al.*, (2015)
	Celtics Africana	88.1	-	20.6	15.1	30.4	24.9	9.02	-	Belete *et al.*, (2012)
	Cordia Africana	90.7	-	14.5	17.7	54.5	49.9	23.7	-	Belete *et al.*, (2012)
	Cordia ovalis	90.1	-	22	16.5	38.4	35.3	13.9	-	Belete *et al.*, (2012)
	Dichrostachys cinera	90.7	-	6.9	9.8	47.9	47.4	18.6	-	Belete *et al.*, (2012)
	Ficus gnaphalocarpa	88.3	-	18.9	10.8	53.6	44	14.5	-	Belete *et al.*, (2012)
	Grewia bicolor	90	-	9.2	15.7	54.7	41.9	21.3	-	Belete *et al.*, (2012)
		-	-	7.88	15.52	51.74	28.88	-	67.63	Abebe *et al.*, (2012)
		-	-	-	13.37 - 15.99	36.35 - 49.91	35.23 - 36.79	-	-	Gemedo, (2004)
	Maytenus arbutifolia	89.1	-	12.9	20.5	32	24.9	7.16	-	Belete *et al.*, (2012)
	Olea europaea	93.4	-	7.4	8.9	36.2	29.5	11.5	-	Belete *et al.*, (2012)
	Premna schimperi	89.5	-	11.9	20.9	39.8	32	10.9	-	Belete *et al.*, (2012)
	Pygeum africanum	91	-	8.25	8.9	37.2	36	24.7	-	Belete *et al.*, (2012)
	Rhus natalensis	89.4	-	10.6	14.1	49.9	31.1	11.3	-	Belete *et al.*, (2012)
	Zizphus mucronata	89.5	-	10.2	16.1	37	26.9	9.83	-	Belete *et al.*, (2012)

Waachuu	*Acacia seyal Del.*	92.28	93.26	8.07	18.63	53.92	32.81	-	-	Gelaye, (2018)
		-	-	7.8	15.86	23	15.36	-	91.47	Abebe *et al.*, (2012)
	Acacia senegal	91.82	91.66	10.54	29.03	48.96	23.56	-	-	Gelaye, (2018)
	Cadaba farinosa	91.52	88.72	16.29	28.42	47.25	20.2	-	-	Gelaye, (2018)
	Acacia brevispica	-	-	6.11	19.62	31.8	19.09	-	81.82	Abebe *et al.*, (2012)
		-	-	-	20.64 - 23.27	35.58 -42.2	23.23 - 26.99	-	-	Gemedo, (2004)
	Vernonia cinerscens	-	-	8.39	14.47	46.19	25.15	-	93.35	Abebe *et al.*, (2012)
	Maracaa	-	-	8.67	13.65	44.47	34.73	-	73.62	Abebe *et al.*, (2012)

Mineral Composition of Indigenous Fodder Tree (Browse) and Shrubs Species

Browses are generally better in supplying minerals to range animals. The mineral content of some major fodder tree species found in pastoral and agro-pastoral of Ethiopia were analyzed and documented by Derero and Kitaw (2018). According to his report there were varies of mineral concentrations among browse species. Ziziphus spina-christi was the most phosphorous rich tree species and A. tortilis had the lowest phosphorous content. Cordia sinensis and Ziziphus spinachristi had the highest and highly comparable amount of potassium, and T. indica foliage had the least content of potassium. Out of the macro minerals, calcium was the most abundant mineral and constituted 73%, followed by potassium (18%) and magnesium (7%), and phosphorus was the rarest of all accounting for only 2% of the amount of the macro-minerals found in indigenous fodder tree species.

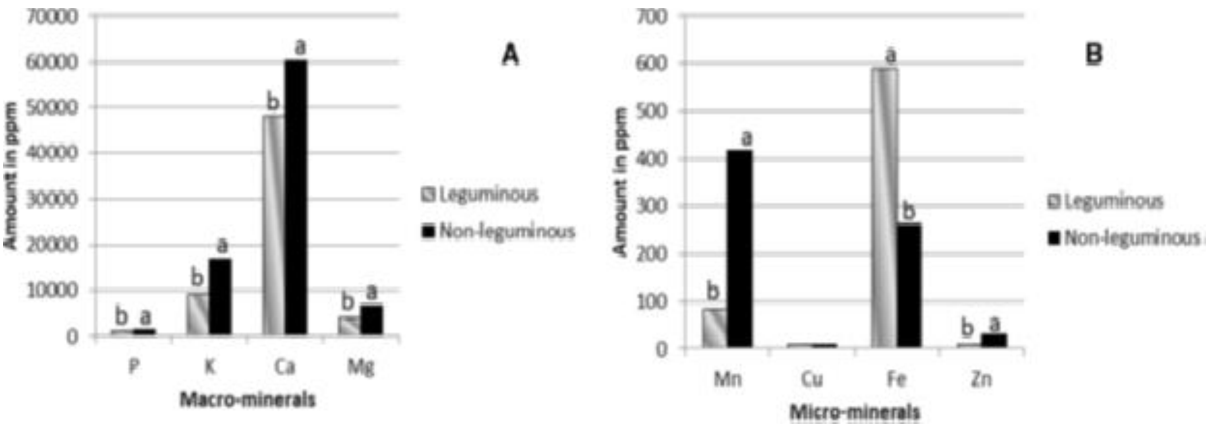

Fig2. *Amount of macro-minerals (A) and micro-minerals (B) in leguminous and non-leguminous species.*

(Source: Extracted from Derero and Kitaw, 2018)

With regard to the micro-minerals, there were varied among the fodder tree species (Derero and Kitaw, 2018). The amount of manganese was exceptionally high in Dobera glabra. For the remaining species, it varied from 43 to 90 ppm. Copper was absent in A. tortilis, B. discolor and Cordia sinensis, whereas it varied from 4 to 28 ppm, and hence it was the highest in T. indica foliage. The iron content was exceptionally high in T. indica, and for the rest it varied from 218 to 457 ppm. Zinc was the highest for B. discolor and the least for A. nilotica (Table 6). Out of the micro-minerals, iron and manganese were the most abundant minerals and constituted 57% and 39%, respectively. Zinc and copper were the rarest minerals constituting 3% and 1%, respectively, of the micro-minerals found in indigenous fodder tree species.

Table 8. *Mineral levels of some fodder tree species in rangeland of Eastern Ethiopia*

Local name	Tree species	Macro-mineral (ppm)				Micro-mineral (ppm)			
		P	K	Ca	Mg	Mn	Cu	Fe*	Zn
Gessalto	A.nilotica	1139	8938	35159	2976	81	2	319	3
Ajjoo/ Deweni girar	A.tortilis	987	11625	58920	4574	90	0	457	4
	B. discolor	1099	17425	48452	6260	43	0	218	21
	Cordia sinensis	1812	18375	77380	4697	78	0	269	9
	Dobera glabra	1070	13354	78351	12022	1415	11	230	27
Koat	*Tamarindus indica*	1673	6700	50315	5467	81	28	1075	26
Giba/kurkura	*Z. spina-christi*	2238	18833	34904	4083	67	23	327	62

(Source: Extracted from Derero and Kitaw, 2018)

Anti- Nutritional Factors in Forages

The anti-nutritional factors may be defined as those substances generated in natural feed stuffs by the normal metabolism of species and by different mechanisms e.g., inactivation of some nutrients, diminution of the digestive process or metabolic utilization of feed which exert effects contrary to optimum nutrition (Kumar, 1991). Being an anti-nutritional factor is not an intrinsic characteristic of a compound but depends upon the digestive process of the ingesting animal, e.g., Trypsin inhibitors, which are anti nutritional factors for mono-gastric animals; do not exert adverse effects in ruminants because they are degraded in the rumen (Kumar, 2003). The utility of the leaves, pods and edible twigs shrubs and trees as animal feed is limited by the presence of ANFs. The reason of ANFs in plants seems to be as a way of storing nutrient or as a means of defending their structure and reproductive elements (Harborne, 1989). Anti-nutritional factors diminish animal productivity but may also cause toxicity during periods of scarcity or confinement when the feed rich in these substances is consumed by animals in large quantities. The major anti nutritional factors of the forages were listed below.

Oxalates

Oxalic acid (chemical formula HOOC-COOH) is a strong organic acid, which is widely distributed in nature in both plants and animals. However, plants contain more oxalic acid than animals. The name comes from the plant Oxalis (wood sorrel) from which it was first isolated. Oxalic acid has the ability to form a strong bond with various minerals, such as sodium, potassium, magnesium and calcium. When this occurs, the compounds formed are usually referred to as oxalate salts. Thus, “oxalate” usually refers to a salt of oxalic acid, one of which is calcium oxalate (Michael, 2002).

Various tropical grasses contain soluble oxalates in sufficient concentration to induce calcium deficiency in grazing animals. These include Cenchrus ciliaris, Digitaria decumbens, Setaria sphacelata and Pennisetum clandestinum. However, they may be toxic if fed for extended period of time (Rahman and Kawamura, 2011). Oxalates react with calcium to produce insoluble calcium oxalate, reducing calcium absorption. This leads to a disturbance in the absorbed (Calcium: Phosphorus) ratio, resulting in mobilization of bone mineral to alleviate the hypocalcemia. The oxalate content of grasses is highest under conditions of rapid growth with concentrations as high as 6% or more of dry weight (Cheeke, 1995). Young plants contain more oxalate than older plants, during early stages of growth; there is a rapid rise in oxalate content followed by a decline in oxalate levels as the plant matures.

Tannins

Browse trees and shrubs contains secondary plant compounds mainly tannin in their leaves and pods that are produced as a defense mechanism against tissue invasion by microorganisms and destruction by herbivore. Tannins occur almost in all vascular plants and have two different group compounds of hydrolysable tannins and condensed tannins. The condensed tannins have more profound digestibility-reducing effect than hydrolysable tannins. Condensed tannin is widely distributed in nature and could affect feed intake and digestibility. Aster et al., (2010) reported the concentration of Condensed Tannin (CT) ranged from negligible concentration in Balanites aegyptiaca to 332 g/kg DM in Acacia tortilis. The concentration of condensed tannins above 4 per cent has been reported to be toxic for ruminants as they are more resistant to microbial attack and are harmful to a variety of microorganisms (Waghorn et al., 1990).Tannin content of feed are affected by many factors like species, genotype and stage of growth, parts of plant, season of growth and environmental factors such as temperature, rain fall, draught, cutting and defoliation by herbivores.

Cyanogens

Cyanogens occur widely in plants and in diverse forms and they are glycosides of a sugar and cyanide containing aglycone. Cyanogens can be hydrolyzed by enzymes to release HCN by enzymes that are found in the cytosol. Damage to the plant occurs when the enzymes and glycoside form Hydrogen cyanide (HCN). The hydrolytic reaction can take place in the rumen by microbial activity. Hence, ruminants are susceptible to CN toxicity than non- ruminants. The HCN is absorbed and is rapidly detoxified in the liver by the enzyme rhodanese which converts CN to thiocyanate. Excess cyanide ion inhibits the cytochrome oxidase. This stops ATP formation, tissues suffer energy deprivation and death follows rapidly (Sarah robson, 2007).

Saponins

Saponins are glycosides containing a polycyclic aglcone molecule of either C27 steroid or C triterpenoid (collectively termed as 30 sapogenins) attached to a carbohydrate. They are widely distributed in the plant kingdom. Saponins are characterized by a bitter taste and foaming properties. Erythrocytes lyse in saponin solution and these compounds are toxic when injected intravenously. Symptoms include listlessness, anorexia, weight loss and gastroenteritis.The adverse effects of saponins can be overcome by repeated washing with water which makes the feed more palatable by reducing the bitterness associated with saponins (Joshi et al., 1989).

Nitrates

Nitrate poisoning is better described as nitrite poisoning. When livestock consume forages, nitrate is normally converted in the rumen from nitrate to nitrite to ammonia to amino acid to protein. When forages have an unusually high concentration of nitrate, the animal cannot complete the conversion and nitrite accumulates. Nitrite is absorbed into the bloodstream directly through the rumen wall and converts haemoglobin (the oxygen carrying molecule) in the blood to methaemoglobin, which cannot carry oxygen.

Factors affecting the severity of nitrate poisoning are the rate and quantity of consumption, type of forage, energy level or adequacy of the diet. Benjamin, 2006, reported that sheep and cattle fed poor diets seem to be more susceptible to nitrate poisoning. A critical level at which the nitrate toxicity effects occurred were feeds containing nitrate nitrogen over 4000 ppm are potentially toxic (John Andrae, 2008). Most of the nitrate accumulates in stem, followed by leaves and very little in the grains (Singh et al., 2000).

Mimosine

Mimosine, a non protein amino acid structurally similar to tyrosine, occurs in a few species of mimosa and all species of closely allied genus leucaena. Concern has arisen because of the importance of L. leucocephala, in which the level of mimosine in the leaf is about 2-6% and varies with seasons and maturity. In non-ruminant animals mimosine causes poor growth, loss of hair and wool, swollen and raw coronets above the hooves, lameness, mouth and esophageal lesions, depressed serum thyroxine level and goiter (Kumar, 2003). A solution to the momosine problem could be the development of low mimosine cultivars and feed Leucaena mixed with other feeds.

Factors Affecting Nutritive Value of Forages

Schut et al. (2010) stated that several factors affected forage quality, which can be pointed out to: vegetative stage of plant growth, plant species, climate, soil, temperature, and management factors. Several factors contribute towards the nutritive value of forages which include species, plant part, stage of maturity and climatic variables. Those factors that have been reported to affect the nutritive value of herbaceous plants are seasonal variability (Teka et al., 2012), Climate, soil nutrient status and production location (Tessema et al., 2011), grazing pressure (Henkin et al., 2011) and management aspects. Spatial distributions of grasses also affect the nutritive quality of common grass species (Keba et al., 2013).

Season and Species Variability

The availability and quality of different browse and grass species vary from season to season due to marked seasonality in rainfall distribution that affects the growth and development of the plant species, particularly that of the grasses and other herbaceous Species (Adugna 2008 and Abebe et al., 2012). Seasonal variation is one of the important factors in driving the dynamics of forage quality (Arzani et al., 2008). Adugna and Abebe (2007) noted that in semiarid areas, there is a marked seasonal variation in availability and quality of feed resources due to marked seasonal variation in rainfall distribution. A seasonal change of neutral detergent fiber content in tropical rangelands are routinely noticed and occurs due to maturity and the age of grass species with progress of season from dry to rainy seasons (Evitayani et al., 2004).

Lower wet season neutral detergent fiber content compared to dry season for grass species was reported by Abebe et al., (2012). The high levels of neutral detergent fiber during the dry season might be due to high lignifications with advanced stage of plant maturity (Hussain and Durrani, 2009). Gelayenew (2012) and Teka et al. (2012) showed that the acid detergent fiber content of tropical grasses being lowest in the wet season and highly increased during the dry season.

Soil Nutrient Status of Production Location

Wide ranges of soil texture and variations in soil structure have the potential of contributing to the variation in plant quality (Angassa et al., 2012). The availability and quality of natural pastures vary with altitude, rainfall, soil type and cropping intensity. The level and distribution of available soil nutrients and water are the main limiting factors (Adugna, 2008). The type of soil may influence the composition of the pasture especially its mineral content. Plants normally react to mineral deficiency in the soil either by limiting their growth or by reducing the concentration of the particular minerals in their tissues, or more usually by both. The acidity of the soil is also an important factor which can influence the uptake of many trace elements by plants (Kasale, 2013).

Management Aspects and Grazing Pressure

Pastures should be managed to maintain a leafy canopy that is free of weeds and overly mature herbage to optimize forage quality. There is much controversy about how to achieve this target. Improper stocking rate, unplanned fertilizer application and fail to balanced forage quantity with animal requirements are the most important management factors that hinder animal performance and minimize forage intake (Adesogan et al., 2015). High grazing pressure reduces the available biomass for the process of decomposition in the soil (Keba et al., 2013).

Stage of Maturity

Tropical grasses generally grow and mature faster and reach senescence more quickly than temperate grasses, thus becoming more fibrous and less digestible within a short period of time (Hennessy et al., 2000). The protein content and digestibility of most grass species decline rapidly with advancing physiological maturity of the plants and reaches very low levels during the dry season. Most forage crops will have a 20% loss in total digestible nutrients and a 40% loss in protein by a delay of only 10 days past the most desirable stage of harvest. In general, late cutting of hay can cause a loss of about 20% in digestibility of the forage and shattering of leaves may cause a loss of about 20% of the nutritive value of the forage (Adugna, 2008).

The crude protein content of individual grass species was declined as the stage of maturity increases from the main rain season towards the cool dry season and often declines with increasing plant structural constituents (neutral detergent fiber, acid detergent fiber and lignin). This is largely due to the changes associated with the advancing stage of maturity of individual species (Keba et al., 2013). The low protein levels and high accumulation of neutral detergent fiber and lignin in mature tropical grasses have been pointed out as being major factors that contribute to poor digestibility and animal performance (Paul et al., 2006).

CONCLUSIONS

Many indigenous forage species available in different areas of Ethiopia were identified. They were mostly located in grazing lands, rangelands and rift valley areas of the country. The major Indigenous grasses, Cenchrus ciliaris, Chrysopogon aucheri, Digitaria milanjiana, Eragrostis papposa, Panicum maximum, Heteropogon contortus, Aristida adoensis, Hyparrhenia rufa, Pennisetum polystachyon and Brachiaria humidicola belong to Poaceae family were located in different areas of the country. From herbaceous legume species in Ethiopia Trifolium species dominates with few legume species. Indigenous fodder tree species are critical feed resources for the pastoralist and agro-pastoralists and also dominated by small holder farmers for important source of feeds in Ethiopia. The CP content of grass species was falls under the category of low quality forages. The structural constituents (NDF, ADF and ADL), and DM in grass species were higher, with critical implications on forage quality and the sustainability of livestock production. Overall, the low accumulation of CP and increased level of structural fibers were a clue of poor quality of forage. It seems that the nutritional quality of herbaceous forage is more influenced by the stage of maturity, agro-ecological difference, and season. The grass quality attributes generally indicate that the vegetation is poor in supplying grass of required quality. The grass species identified well also shown to have moderate potential based on their in vitro digestibility values. The browse species evaluated have good potential as livestock feed and particularly as a supplement for low quality roughages during dry season.

RECOMMENDATIONS

- Since the quality attributes of the indigenous forages specially grasses are poor, the protein and energy supplementation found to be essential.
- Indigenous forages are the primary feed resources for livestock, so proper stage of utilization and management should be important for optimum production and productivity of livestock.
- Conducting research development should be vital for indigenous forages which were smart in the country to improve and enhance their production potential.

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