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IDENTIFICATION AND NUTRITIVE VALUE OF POTENTIAL FODDER TREES AND SHRUBS IN THE MID RIFT VALLEY OF ETHIOPIA

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ABSTRACT

The aim of this study was to identify potential browse species in the mid Rift Valley of Ethiopia and to assess their nutritive value. A total of 120 household from four districts in the mid Rift Valley of Ethiopia were interviewed to identify locally important browse species. Herbarium samples were collected for identification and/or confirmation of the scientific names. Samples were also taken for chemical composition analysis. A total of 18 different browse species were identified, which are regarded as being important for different classes of livestock. The CP value of the edible component ranged between 8.95-20.9%, the NDF values ranged from 30.41-78.55%, the ADF values ranged from 19.42-47.5%.,and the ADL values ranged from 7.16 to 24.68. Generally the differences in chemical composition between different browse species were significant. These results indicate that there is a number of promising browse species in the indigenous flora. However, apart from chemical composition, they need to be characterized further in terms of palatability, digestibility, feed intake, animal response trials and anti-nutritional factors, in order to be able to enhance their utilization in the future.

Keywords: Mid rift valley browses, chemical composition, and nutritive value.

INTRODUCTION

In Ethiopia, despite of having good number of farm animals, per unit productivity is quite low. Among other factors, poor nutrition is a major constraints limiting livestock performance. Consequently, this leads to high mortality amongst livestock, longer calving intervals, and substantial weight loss, particularly during dry season usually extending from December to May in most of Ethiopia (EARO, 2000).

In most of the Rift Valley of Ethiopia livestock depend on natural grazing and crop residues. Animals have to survive on range that also has a low nutritional value for most of the year. The crude protein (CP) content of range vegetation is between 8 to 12% of dry matter (DM) at the beginning of rainy season, but drops to 2-4% during dry season (Amaning-Kwarteng, 1991), leading to prolonged periods of animal malnutrition.

Browse species have considerable potential in mixed crop livestock production systems, to supplement low quality feeds, fix atmospheric nitrogen, provide fuel and shelter and to help in soil and water conservation. Moreover, the ability of most browse species to remain green for a longer period is attributed to deep root systems, which enable them to extract water and nutrients from deep in the soil profile and this contributes to the increased CP content of the foliage (Le Houérou, 1980).

The mid Rift Valley has mixed crop-livestock production systems with livestock production being dominated by the semi-arid to arid climatic conditions. Browse species can make a large contribution to livestock nutrition as they depend on such species during dry season. Despite the wider use of observed indigenous browse species, little has been documented with regard to the extent of their utilization and their potential nutritive value. This suggests that there is a need for research to characterize these feed resources in order to sufficiently understand their constraints for efficient utilization and to identify their relative potential. The objectives of this study were therefore, to identify potential browse resources in the mid Rift Valley of Ethiopia, and to determine their chemical composition when fully mature in the wet season.

MATERIALS AND METHODS

Description of study area: The study was conducted in the mid Rift Valley of Oromia, Ethiopia. The Rift Valley (includes the East Showa zone of Oromia) has a width of 40-60 km and is more than a thousand km long, surrounded by highland plateaus. The altitude ranges from 500 to 2000 meters above sea level (m.a.s.l) and has a semi-arid climate. The area has an erratic, unreliable and low rainfall, averaging between 500 and 900 mm per annum. The rainfall is bi-modal with the long rainy

season from June to September (Abule *et al*., 1998). Four districts namely Fantale, Adami Tulu Jiddo Kombolcha, Arsi Negelle and Dugda Bora were selected to represent the existing farming systems. Representative Peasant Associations (PA's) were purposely selected in compliance with their proximity to roads and accessibility of infrastructure. Three PA's from each district (a total 12 PA's) were selected to represent the study area. Random sampling of households was employed and a total of 120 households were interviewed. Structured and semi-structured questionnaires were used to collect information from key informants on types of browse species available, their vernacular names, season favored, palatability, parts of plants eaten and relative attractiveness to animals or animal preferences. Group discussions were held to clarify the understanding of all issues.

Sampling: Herbariums of sample species were made in duplicate. One duplicate was sent to Addis Ababa University for family and scientific name identification, while the other was kept at the laboratory at the Adami Tulu Research Centre.

Samples of these plant species were collected for chemical composition analyses. Sampling was done in the wet season (middle of the long rainy season) when the leaves of trees and shrub species were fully re-grown. During the sampling period, browse leaves and twigs of less than 5 mm stem diameter were hand plucked. The samples were kept under shade until sampling for the day was completed. After this, samples were sun dried until the field work was completed. Finally, samples were dried to constant mass in an oven at 55ºC for 48 hours before subsequent nutrient analyses.

Determination of chemical composition: Selected species (which have not been characterized previously) were considered for determination of chemical composition. The oven dried samples were ground in a Willey Mill to pass through 1mm sieve for the determination of chemical composition. Feed samples were analysed for DM and ash using the method of AOAC (2000). Nitrogen was determined using the micro-Kjeldahl method (AOAC, 2000). Crude Protein (CP) was calculated as N x 6.25. The Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) and Acid Detergent Lignin (ADL) were analyzed according to Van Soest *et al*. (1991).

Data analysis: The data were organized, summarized and analyzed using the SAS statistical package (SAS, 2001). For data involving frequencies, descriptive statistics were employed, where as quantitative variables were analyzed using analysis of variance procedures and when the F-test showed significant differences, the Tukey test was used to separate group means.

RESULTS AND DISCUSSION

Trees and shrubs utilized as feed: The list of forage browse species identified as locally important are presented in Table 1, where the scientific names, percentage of respondent, parts taken by the animals, and the animal groups that most favored the feed are indicated. About 18 indigenous browse species were identified being used as feed sources by cattle, goats and sheep. All livestock in the survey area consumed browse species at one time or another during the year, depending upon availability and the preference by animal species. According to the key informants and from the group discussions, cattle and sheep selected the most palatable grasses and legumes during the wet season, while goats browsed on trees and shrubs. As the herbaceous component become more abundant and nutritious during the wet season, cattle and sheep are less attracted to the browse species. However, during the dry season, the herbaceous components are less abundant and often become more fibrous. In this season cattle and sheep depend first on leaves and succulent twigs of browse species. As the dry season progresses, however, less palatable species are also browsed by livestock during the critical dry season. The key informants also indicated that the less palatable species and/or some dried or wilted plants, which are assumed to be poisonous, are eaten by livestock during the critical feed shortage time in dry season. The utilization of browse species by livestock as a feed has also been described by many authors in Ethiopia (Abule, 2003; Beyene, 2009; Teferi, 2006) and also in sub-Saharan Africa (Le Houréou, 1980).

Goats are able to select between plan parts favor leaves of browse species. Where controlled grazing is exercised, through herding, they also selectively utilize some nutritious herbs. In the study area key informants indicated that *Acacia tortilis, Acacia mellifera*, *Ziziphus mucronata*, *Capparis fascicularis*, *Celtis africana*, *Grewia bicolor*, *Olea europaea*, *Dichrostachys cinerea*, *Balanites aegyptica* were most favored by goats. These browse species are also utilized by cattle and sheep. According to Le Houréou (1980) selection of browse species by animals depends on many factors, including the feeding preference of a given animal species. Thus, while some animal are primarily grazers, others are mainly browsers. Some are very strict concerning their diets, while others are more flexible or versatile. Pratt and Gwynne (1977) described that grazers sometimes become browsers in order to balance their diet during feed shortages especially in the dry season. Other animals, such as goats and camels are browsers to a large extent and can ensure normal growth on a pure browse diet. This was in agreement with the ideas of key informants during times of feed shortage such as the dry seasons of mid Rift Valley of Ethiopia. As the nutritional value of browse species varies, browse alone cannot satisfy the

maintenance requirement of cattle, whereas, goats can meet their maintenance and production requirements from browse and sheep can only satisfy their maintenance requirement (Le Houérou, 1980). This explains why only goats and camels can survive on the degraded rangelands so often found in arid and semi arid zones, where browse constitutes most of the feed resources (Le Houréou, 1980).

Table 1 List of shrub and tree species, identified as important to livestock, in the mid Rift Valley of Ethiopia.

Scientific name	% of respondents (n)	Favored plant parts	Animal species	palatability references
Acacia mellifera	45.0(54)	Leaf	Cattle, sheep, goat	Angasa and Oba 2010
Acacia tortilis	95.8(115)	leaf, twinges and pod	cattle, sheep, goats	Angasa and Oba 2010
Arundinaria alpine	35.8(43)	Leaf	Cattle, sheep, goats	Bekele 2006
Balanites aegyptica (L.) Del.	79.2(95)	Leaf and twigs	Cattle, goats	Ebro *et al*. 2007 and Angasa and Oba 2010
Capparis fascicularis DC.	54.2(65)	Leaf and twigs	Cattle, goats	Ebro *et al*. 2007
Caucanthus auriculatus	20.8(25)	Leaf	Cattle, goats	Ebro *et al*. 2007
Celtis Africana	25.0(30)	Leaf and twigs	Cattle, sheep, goats	Bekele 2006
Cordia Africana	63.3(76)	Leaf	Cattle, goats	
Cordia ovalis	20.8(25)	Leaf	Cattle, goats	Ebro *et al*. 2007
Dichrostachys cinerea	70.0(84)	Leaf and twigs	Cattle, goats	Angasa and Oba 2010, Ebro *et al*. 2007
Ficus gnaphalocarpa	77.5(93)	Leaf	Cattle	Ebro *et al*. 2007
Grewia bicolour	75.0(90)	Leaf and twigs	Cattle, sheep, goat	Angasa and Oba 2010, Bekele 2006
Maytenus arbutifolia	15.8(19)	Leaf	Cattle	
Olea europaea,	77.5(93)	Leaf	Cattle, sheep, goats	
Premna schimperi	15.8(19)	Leaf	Cattle, goats	Tefera *et al*. 2006
Pygeum africanum	63.3(76)	Leaf and twigs	Cattle, sheep, goat	Ebro *et al*. 2007
Rhus natalensis	54.2(65)	Leaf and twigs	Cattle, goats	Ebro *et al*. 2007, Angasa and Oba 2010
Ziziphus mauritiana.	63.3(76)	leafy and twings	cattle and goats	

The most widely utilized browse species, as indicated by the interviewed farmers/pastoralists, 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%), . Some of these are similar to those documented by Beyene (2009) in south western Ethiopia who indicated *Rhus natalensis*, *Bauhinia farea*, *Grewia ferruginea*, *Acacia seyal* and *Deinbollia kilimandscharica* as the common browse in the Gembella region. 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. On the other hand, *Acacia* species and *Grewia mollis* were reported by Abule (2003) as the most commonly utilized species in the Rift Valley of Ethiopia.

Indigenous knowledge and practices of farmers/ pastoralist: The indigenous knowledge and/or practice associated with the use of selected plants is documented in Table 2.

In the mid Rift Valley production system, the pods of *Acacia tortilis* were commonly eaten by animals (Solomon *et al*., 1999; Abule, 2003). The utilization of *Acacia* species is variably described by many authors in sub Saharan Africa (Le Houréou, 1980). In the mid Rift Valley of Ethiopia the pastoralists and farmers collect pods of tree species (including those of *Acacia tortilis*) and keep them at their homes for the purpose of feeding calves and sick animals that can not walk long distances in search of feed and water during the dry season. For small ruminants (especially goats) the herders leads the animals to *Acacia* trees and shake the pods from the trees to feed the animals. The local instrument used by herders is made from wooden stick bent at the top, called locally as "Okko". The farmers also indicated that during the dry season heifers fed on *Acacia* pods will come on heat easily. This can be probably due to high protein content of the *Acacia* pods that have about 18.8% CP. This level is apparently sufficient to support microbial rumen fermentation. In a different study at Adami Tulu, Solomon *et al*. (1999) reported that Rift Valley goat kids fed on *Acacia* pods, perform better than the un-supplemented group fed maize stover due to the high CP content of the pods. In contrast, Brewbaker (1986) reported that pods have a lower CP content with a higher organic matter (OM) digestibility than leaves. Although

Acacia species contain tannin and other anti-nutritional factors. The use of dried pods or wilted leaves is known to reduce the effects of these anti-nutritional factors (Kaitho, 1997).

Table 2. Lists of trees and shrubs that have medicinal value and some practices/indigenous knowledge of farmers/pastoralists.

Scientific name	*Local name*	*Farmer/pastoralists practice/ knowledge in utilizing*
Acacia tortilis	Ajjoo	Makes cows and heifers to come on heat
Acacia mellifera	Saphansa	Used for fumigation of local milk containers
Acacia seyel	Waachuu	The root is used for medicinal value
Allophylus abyssinicus	Diriba	Can replace milk for weaned calves
Becium sp.	Daddoo	Has medicinal value
Boswellia hildebranti	Dhakara	Medicinal values
Combretum molle	Biqqaa	Replace milk for calves and fed in dry times
Cyphostemma sp	Chabbii loonii	Extracted for wound healing
Endostemen tereticaulis	Urggoo	Fumigation of milk containers for smell and anti-microbial effect
Euclea shimperi	Mieessaa	Extracted for medicinal value, important ceremonial plant locally
Grewia ferruginea	Dhooqonuu	Used for placental drop
Ocimum sauve	Hancaabii	Has medicinal value
Rubus apetalus Poir	Goraa	Edible fruit by human(herders)
Securinega virosa	Qacacuulee	Edible fruit by human(herders)
Vernonia amygadalina	Eebicha	Increase milk yield

In addition to *Acacia tortilis* pods, there are different trees and shrubs used by pastoralists/farmers for different purposes (Table 2). *Allophylus abyssinicus* (Dirbaa) is often used by the pastoralists to replace milk for weaned calves. This feed is available year-round but is mostly used during the dry season. Other trees and shrubs thought to be good for suckling calves, in the dry season, are *Combretum molle* (biqqaa) and *Vernonia amygadalina* (Ibicha). The latter is known to increase milk yield in lactating cow. The frequent utilization of such material may be due to the higher crude protein content. According to key informants, there are some plant species that have multipurpose functions, e.g. *Hagenia abyssinea* (Heexoo) and *Ocimum sauve* (Hancaabii), while *Grewia ferruginea* (Dhoqona) is used for placental drop for cows that have the problems of retained placenta.

Another important practice common in the mid Rift Valley area is allowing animal access to grazing lands with high mineral concentrations. This soil is traditionally called "*Bole"* or "*Bojii"* and it serves as a source of certain minerals. For example the analyzed samples of such soils were found to contain on average (ppm): 44.2 P, 12.12 Fe, 11.2Mn, 1.08 Cu, 0.29 Zn, 1.06 Ca (meq/100g), and Mg (meq/100). The practice is intended to keep the animals healthy and more productive. In this area there are two types of such soils that can be used as a source of mineral supplement, locally called "keela" and "hora". The former has higher concentration of phosphorous (Nega, 2006), but both are thought to induce animals to come on heat if animals are allowed access to these soils for a period of two weeks before they are allowed to graze flush growth of forages at the start of the short rainy season.

Potential Nutritive value of the trees and shrubs: The chemical composition of different browse species in the study area is presented in Table 3. There were differences in nutrient content between the studied browse species. The ash value ranged from 6.90-22.0%. The highest value was recorded for *Cordia ovalis* R.Br. while the lowest value was recorded for *Dichrostachys cinera*. The CP value of the edible components ranged between 8.95-20.9%, the highest CP value was recorded for *Premna schimperi* while the lowest value was recorded for *Olea europaea*. The NDF value ranged from 30.41-78.55%. The highest NDF value was recorded for *Arundinaria alpine* and the lowest was recorded for *Celtis Africana.* The ADF value ranged from 19.4-49.5%, with the highest being recorded in *Cordia abyssinica* while the lowest value was recorded in *Acacia mellifera*. The ADL value ranged from 7.16 to 24.7, with the highest being recorded for *Pygeum africanum* and the lowest value in *Maytenus arbutifolia*. Generally the differences within genera and between species were significant.

Generally browse species are richer in CP, minerals and digestible nutrients than grasses (Devendra, 1990; Topps, 1992). The chemical composition of indigenous browse species in the present study has on average 14.4% CP, 45.3% NDF, 35.3% ADF, and 13.2% ash and except for the ADF, the these values are comparable to those reported by various authors (Heneidy, 1996; Shayo and Uden, 1999; Le Houréou, 1980) who indicated mean content of 14.73% CP, 45.17% NDF, 43.1% ADF, 11.01% ash and CF content

of 21.48%. High variability in the nutrient content of browse species was also reported by Dicko and Sikena (1992), Bulo *et al*. (1985) and Little *et al*. (1989). Dicko and Sikena (1992) reported a variation of CP content in different browse species of 6 to 23%. According to Solomon (2001) the high variability in the nutrient content of browse could be attributed to within species variability owing to factors such as plant part, harvesting regime, season and location, and these factors appear to influence chemical composition, palatability, rumen degradability, digestibility, voluntary intake and nutrient utilization by animals. The difference in nutrient content between species and within genera could be associated with the inherent nature of the species. Of course, there could be morphological differences within the same species and differences in lignin, cellulose and hemi-cellulose (Beyene, 2009). Compared with other sources of forage, browse materials generally have a high ether extract and moderate ash content; and generally lower nitrogen- free extracts (Brewbaker 1986). In addition to a high CP content, browse species also provide vitamins and mineral elements, which are often lacking in mature natural grassland pastures, especially during the dry season (Skerman *et al*., 1988).

Table 3 Chemical composition (mean ± SE) of the browse species in the mid-rift valley of Ethiopia.

Scientific name	*Composition(%DM)*						
	DM	***Ash***	***CP***	***NDF***	***ADF***	***ADL***	***Cellulose***
Acacia mellifera	91.9 ± 0.25^{c}	12.6 ± 0.23^{h}	12.6 ± 0.2^{k}	33.7 ± 0.02^{o}	19.4 ± 0.02^{o}	8.86 ± 0.03^{0}	12.3 ± 0.04^{p}
Arundinaria alpine	92.5 ± 0.10^{b}	13.9 ± 0.01^{f}	12.6 ± 0.02^{k}	78.5 ± 0.05^{a}	47.5 ± 0.0^{b}	9.5 ± 0.00^{m}	28.0 ± 0.01^{b}
Balanite aegyptica	87.4 ± 0.0^{k}	21.2 ± 0.0^{b}	15.2 ± 0.0^{g}	44.6 ± 0.0^{h}	33.8 ± 0.00^{i}	11.1 ± 0.0^{j}	22.4 ± 0.0^{e}
Capparis fascicularis	93.2 ± 0.02^{a}	10.7 ± 0.01^{k}	14.7 ± 0.05^{i}	59.8 ± 0.0^{b}	42.3 ± 0.04^{e}	10.9 ± 0.05^{k}	27.8 ± 0.05^{c}
Caucanthus auriculatus	90.9 ± 0.01^{de}	11.8 ± 0.04^{j}	14.6 ± 0.01^{i}	41.6 ± 0.05^{i}	33.8 ± 0.01^{i}	12.4 ± 0.02^{g}	22.6 ± 0.04^{d}
Celtics Africana	88.1 ± 0.03^{j}	20.6 ± 0.02^{c}	15.1 ± 0.04^{h}	30.4 ± 0.01^{q}	24.9 ± 0.0^{n}	9.02 ± 0.03^{n}	12.4 ± 0.03^{o}
Cordia Africana	90.7 ± 0.01^{e}	14.5 ± 0.02^{e}	17.7 ± 0.03^{c}	54.5 ± 0.02^{d}	49.9 ± 0.03^{a}	23.7 ± 0.02^{b}	17.6 ± 0.03^{l}
Cordia ovalis	90.1 ± 0.03^{f}	22.0 ± 0.02^{a}	16.5 ± 0.04^{d}	38.4 ± 0.02^{k}	35.3 ± 0.02^{h}	13.9 ± 0.01^{f}	18.3 ± 0.04^{j}
Dichrostachys cinera	90.7 ± 0.02^{e}	6.9 ± 0.03^{q}	9.8 ± 0.01^{m}	47.9 ± 0.02^{g}	47.4 ± 0.03^{c}	18.6 ± 0.03^{d}	29.6 ± 0.02^{a}
Ficus gnaphalocarpa	88.3 ± 0.01^{i}	18.9 ± 0.02^{d}	10.8 ± 0.08^{l}	53.6 ± 0.04^{e}	44.0 ± 0.04^{d}	14.5 ± 0.03^{e}	21.4 ± 0.05^{f}
Grewia bicolour	90.0 ± 0.05^{f}	9.2 ± 0.06^{n}	15.7 ± 0.03^{f}	54.7 ± 0.01^{c}	41.9 ± 0.04^{f}	21.3 ± 0.01^{c}	15.8 ± 0.12^{n}
Maytenus arbutifolia	89.1 ± 0.05^{h}	12.9 ± 0.03^{g}	20.5 ± 0.03^{b}	32.0 ± 0.03^{p}	24.9 ± 0.02^{n}	7.16 ± 0.06^{p}	17.2 ± 0.02^{m}
Olea europaea	93.4 ± 0.05^{a}	7.4 ± 0.04^{p}	8.9 ± 0.05^{m}	36.2 ± 0.05^{n}	29.5 ± 0.06^{l}	11.5 ± 0.05^{h}	18.8 ± 0.02^{h}
Premna schimperi	89.5 ± 0.05^{g}	11.9 ± 0.05^{i}	20.9 ± 0.11^{a}	39.8 ± 0.26^{j}	32.0 ± 0.1^{j}	10.9 ± 0.21^{k}	18.4 ± 0.05^{i}
Pygeum africanum	91.0 ± 0.03^{d}	8.25 ± 0.05^{o}	8.9 ± 0.06^{m}	37.2 ± 0.02^{l}	36.0 ± 0.05^{g}	24.7 ± 0.01^{a}	15.9 ± 0.07^{n}
Rhus natalensis	89.4 ± 0.05^{g}	10.6 ± 0.05^{l}	14.1 ± 0.05^{j}	49.9 ± 0.06^{f}	31.1 ± 0.08^{k}	11.3 ± 0.13^{i}	19.0 ± 0.04^{g}
Zizphus mucronata	89.5 ± 0.47^{g}	10.2 ± 0.15^{m}	16.1 ± 0.05^{e}	37.0 ± 0.01^{m}	26.9 ± 0.05^{m}	9.83 ± 0.15^{l}	17.8 ± 0.17^{k}
Mean	***90.3***	***13.2***	***14.4***	***45.3***	***35.3***	***13.5***	***19.7***

[a-p]Different superscript letters within a column indicate significant difference between studied parameters of plants

In the present study some browse species (*Premna schimperi* and *Maytenus arbutifolia*) had a greater CP content than 18%. According to ARC (1980) a minimum of 90gm CP/kg DM of the diet is necessary for adequate microbial synthesis, while Van Soest(1982) reported that less than 1.5% N in the feed DM (94g CP/kg DM) results in reduced ruminal microbial activity, which leads to a reduction in degradation of cell wall and subsequently lowered intake. Most of the Ethiopian dry forages analyzed and roughages had a CP content of less than 9% (mean 6.2%), which suggests that the microbial requirement can hardly be met unless supplemented with protein rich feeds (Seyoum and Zinash, 1989). The high CP content of feeds in the class of protein supplements shows that there is a potential for supplementing with agro-industrial by-products, but there is a question of affordability by smallholder or pastoral farmers. However, the supplementation of low-quality feeds with local protein supplements is impeded at present by a lack of sufficient data on anti-nutritional factor (e.g. condensied tannin), rumen degradability and bio-availability data. Characterizational some of these locally available browse species could enhance their wider utilization, without any need for extra capital to purchase protein concentrate feeds.

Conclusions: This study indicated that a large reserve of plant species in the local flora are available that could be potentially used for livestock feeding. These feeds, if fully exploited, could assist in increasing the level of production and productivity of the livestock resources in the region. However, these feeds, apart from chemical composition, need to be characterized further in terms of palatability, digestibility, feed intake, animal response trials and anti-nutritional factor studies, in order to be able to enhance their utilization in future. *Premna schimperi and Maytenus arbutifolia* contain CP contents of more than 190gm/kg, which indicates a potential for supplementing poor quality roughages.

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