Potential of Mulberry as Feed for Ruminants in Central Tanzania

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Abstract

Ruminant livestock in the semi-arid areas of central Tanzania face serious shortages of adequate and good quality feeds during the dry season, affecting their productivity and reproductive performance. Unfortunately, improvement of growth rates and milk yields of livestock in these areas using commercial supplements is difficult because the supplements are expensive and are not easily available in the remote villages with poor infrastructure. The proposed physical and chemical treatment to improve low quality roughages are also expensive, difficult to apply by the rural people and may result in environmental pollution. Therefore, the use of tree leaves and pods could be an alternative option.

Mulberry is available in Tanzania and in some places (e.g. in the humid northern highlands), the leaves are used to feed the zero-grazed sheep and goats. Mulberry is also present in thesemi-arid areas of central Tanzania, the coast regions and the southern highlands, usually in small quantities (< 5) established around the households. However, only a few farmers are aware of the value of mulberry as a potential source of fodder to livestock.

Studies conducted in the semi-arid areas of central Tanzania showed that mulberry may produce substantial amounts of high quality fodder as well as fuel. Yield of leaves, stems and barks exceeded 20, 31 and 6 t/ha DM, respectively, when harvested two

years after establishment at the end of the rainy season and again in mid dry season. Mulberry leaves are well accepted by livestock and are highly digestible (> 80% DM) with high concentrations of crude protein (14-18% DM). The barks is stripped off and consumed by sheep and goats. Bark is fairly highly digestible (60% DM) with higher CP concentrations (8% DM) than most grasses and stovers available during the dry season. Mulberry leaves contain minimum levels of phenolic compounds compared to most native browse trees and shrubs.

The productivity and quality merits of mulberry makes it a suitable plant to incorporate in the agro-forestry systems of central Tanzania and other areas of Africa with similar climate. However, more studies on mulberry distribution in the whole country as well as studies on agronomic characteristics in different agro-ecological zones are required. Further studies on intake and on productive and reproductive performance of different types and classes of livestock when fed mulberry fodder are suggested.

Introduction

Ruminant livestock in most areas of Tanzania are managed under semi-pastoral and agro-pastoral systems, feeding mostly on natural pasture and crop residues. The amounts of high quality pasture is usually sufficient during the rainy season, but as maturity advances, the nutritive value of the pastures decreases (Shayo and Msangi, 1989). Therefore, available feed resources during the dry season are usually unable to provide sufficient nutrients for reasonable livestock productivity, and livestock generally loose weight, become susceptible to diseases and have reduced breeding performance.

Although supplementation using commercial feeds or by-products such as maize bran and oil seed cakes is widely used to

improve growth rates and milk yields, these supplements are expensive and are not easily available in the remote villages in many areas with poor infrastructure. Similarly, improvement of low quality roughage using physical and chemical treatments are expensive, difficult to apply by rural people and may result in pollution of the environment.

In recent years there has been a growing trend in many tropical regions to identify potentially important feed sources among shrub and tree leaves and pods for inclusion in ruminant diets. The increased importance of trees and shrubs as non-conventional feed resource has been recognized as one of the most effective means of improving forage supply in small-holder livestock production (Blair, 1989). Emphasis on the use of trees in the farming systems is based on the high quality leaves and pods and their over all role they play in the natural ecosystems and human and animal welfare improvement (see Shayo, 1998).

There are a number of introduced and native trees that are important sources of nutrients for livestock in Tanzania. However, some of the introduced trees had difficulties to adapt to the local environment (such as *Leucaena leucocephala*). More over, most native deciduous browse species shed their leaves during the dry season, and during this period, most evergreen species are known to contain some physical structures or chemical compounds, which defend them against herbivory (Coley *et al.*, 1985).

Efforts to explore the potential use of mulberry (*M. alba*) trees as livestock feeds in the semi-arid areas of central Tanzania were initiated by Shayo (1997). There are positive indications that the tree could be an alternative for improving farm animal diets and to reduce feed costs in many production systems. This has prompted more studies on the effect of mulberry leaves on growth and milk production in farm animals (e.g. goats), currently being carried out at the Livestock Production Research Institute in central Tanzania and at the Sokoine University of Agriculture.

This paper presents initial findings of the potential of mulberry for livestock production in the semi-arid areas of central Tanzania.

Distribution and Use of Mulberry

According to Zheng *et al.* (1988) mulberry is both a temperate and a sub-tropical plant grown in many regions of the world, predominantly in eastern, southern and southeastern Asia, southern Europe, southern North America, northwestern South America and parts of Africa. In Africa, it has been reported to occur in the humid, sub-humid and semi-arid areas at an altitude up to more than 1,000m above sea level (Le Houerou, 1980). It is not well known when mulberry was introduced in Tanzania but it appears to have been in the country for many decades. In the humid areas of the northern highlands mulberry trees are incorporated into the intensive farming systems and are widely used to feed sheep and goats in a cut and carry system. In some situations mulberry is used as live fence. However, there have been reports (unpublished) that some missionaries have established mulberry trees for wine making using the fruit.

Apart from the highlands of northern Tanzania, mulberry is also present in the semi-arid areas of central Tanzania, the coastal belt as well as in the southern highlands of Tanzania. So far, there has not been any formal studies on the distribution and use of mulberry in the country. However, survey studies (Shayo, 1997; Omar, 1998) in some villages in two districts of the semi-arid areas of central Tanzania (Mpwapwa and Kondoa districts) showed that mulberry trees were found in 5% of homesteads. The trees were grown close to the dwellings and the number of trees per household did not exceed 5 (average = 2). Some trees were found away from the homesteads, where they were left by farmers who previously occupied the land. The trees were mainly used for a range of purposes: fruit; shade; vegetable (lesser extend);

medicinal purposes; and as fuel wood. The leaves were rarely used for livestock feeding, since most farmers were not aware of this use.

Table 1. Mean yield of mulberry, by fractions, under different spacings at various periods of the year (Shayo, 1997).

Harvest	Spacing[1]	Yield/plant (kg DM)				Yield/ha (t DM)			
		Leaf	Stem	Bark	Total	Leaf	Stems	Bark	Total
1st-2y[3]	S1	0.59[ab2]	0.97[a]	0.18[a]	1.74[a]	16.9[a]	28.2[a]	5.3[a]	50.4[ab]
	S2	0.65[a]	1.37[c]	0.28[b]	2.30[b]	3.4[b]	7.1[b]	1.4[b]	11.8[c]
	S3	0.63[a]	1.12[ab]	0.22[ab]	1.97[ab]	8.5[c]	15.1[c]	3.0[c]	26.6[d]
1st-2y	S1	0.08[c]	1.65[bd]	0.46[c]	2.19[ab]	2.3[b]	47.8[d]	13.2[d]	63.3[b]
+ 190d[4]	S2	0.31[bc]	2.14[d]	0.54[c]	2.98[b]	1.6[b]	11.0[bc]	2.8[bc]	15.4[cd]
	S3	0.14[c]	2.00[cd]	0.49[c]	2.64[ab]	2.0[b]	27.1[a]	6.6[a]	35.7[ad]
2nd-120d[5]	S1	0.14[a]	0.12	0.05[a]	0.31	4.0[a]	3.5[a]	1.4[a]	9.00[a]
	S2	0.13[a]	0.14	0.06[a]	0.33	0.7[bc]	0.7[b]	0.3[bc]	1.7[b]
	S3	0.11[a]	0.14	0.06[a]	0.30	1.5[b]	1.9[bc]	0.8[d]	4.1[c]
2nd-190d[6]	S1	0.05[b]	0.16	0.02[b]	0.22	1.3[b]	4.5[d]	0.6[cd]	6.4[d]
	S2	0.06[b]	0.17	0.02[b]	0.25	0.3[c]	0.9[b]	0.1[b]	1.3[b]
	S3	0.05[b]	0.17	0.02[b]	0.23	0.6[c]	2.3[c]	0.3[b]	3.1[bc]

[1]Plant spacing: S1 = 0.5 x 0.7m; S2 = 1 x 2m; S3 = Double row (1 x 1 x 0.5m).
[2]Means within harvest type in same column with different letters are significantly different ($P < 0.05$)
[3]Harvested 2 years after establishment (1st cutting, end of the rainy season)
[4]Harvested for the first time at the peak of the dry season (190 days after the 1st cutting)
[5]Regrowth harvested 120 days after the 1st cutting (mid-dry season)
[6]Regrowth harvested 190 days after the 1st cutting (peak of the dry season)

Productivity

There are several natural and management factors affecting productivity of mulberry, such as soil and climatic conditions, mode of propagation and harvesting techniques. In general, longer intervals between defoliation have increased total yield; however, the proportion of inedible wood may also increase, leading to decline in forage quality (Ivory, 1990; Shelton & Brewbaker, 1994). On the other hand, as plant spacing is reduced, yield per

plant decreases owing to competition, but total forage yield per unit area increases, as does the leaf:wood ratio (Ella *et al.*, 1989). This was confirmed by Shayo (1997) in a trial to study biomass production at different spacing and harvesting intervals in the semi-arid areas of central Tanzania (Table 1). Although yield per season increased with harvesting interval, the amounts and nutritive value of edible components decreased considerably due to senescence and drop of leaves. Tikader *et al.* (1993) found that maximum mulberry leaf yields could be obtained by harvesting 3 times/year. Results presented in Table 1, show that mulberry harvested twice, at the end of rainy season and in mid dry season, gave considerably high amounts of fodder.

Table 2. Proportion of mulberry fractions as affected by spacings and harvest time (Shayo, 1997).

Type	Treatment[1]	Part of the plant (%)		
		Leaf	Stem	Bark
First harvest at 2y	S1	33.6	55.9	10.5
	S2	28.3	59.6	12.2
	S3	31.8	56.8	11.4
	Mean	31.2a[2]	57.4a	11.4a
First harvest at 2y + 190d	S1	3.6	75.5	20.9
	S2	10.2	71.7	18.1
	S3	5.5	75.9	18.6
	Mean	6.4b	74.4b	19.2b
Regrowth at 120d	S1	44.7	39.4	15.9
	S2	39.3	42.5	18.2
	S3	36.1	45.4	18.4
	Mean	40.0	42.4c	17.5b
Regrowth at 190 d	S1	20.5	70.1	9.3
	S2	23.7	66.8	9.5
	S3	20.3	71.9	8.0
	Mean	21.5d	69.6b	8.9a

[1]Plant spacing: S1 = 0.5 x 0.7m; S2 = 1 x 2m; S3 = Double row (1 x 1 x 0.5m).
[2]Means in the same column with different letters are significantly different ($P<0.05$).

It is interesting to note that mulberry harvested during the peak of the dry season developed considerable amounts of shoots. As reported by Walker (1980), regeneration of new shoots after pruning is independent of rainfall. The advantage with the new shoots is that they are more tender and nutritious than ordinary branches and grow more rapidly. This is also reflected by higher proportion of leaf:stem in younger plants and regrowths than older plants (Table 2).

Nutritive Value

Mulberry leaves have shown to be highly digestible and contain high concentrations of crude protein (CP) and minerals, and low cell wall contents (Table 3). This suggests that could be used to minimize nutrient deficiencies faced by grazing animals in the semi-arid areas of central Tanzania. Also, the bark is reasonably digestible, with CP concentrations higher than in dry season pastures and crop residues. Older leaves contain lower concentrations of CP than young leaves (Table 3). Young leaves and bark are more degradable than old leaves and bark (Shayo, 1997). The rate of *in sacco* degradation of leaves was high, 70 – 80% at 24h of incubation. The study also showed that degradability of the old bark was maximal (about 70% of the DM) after 72h. Another advantage of mulberry leaves is that they contain considerably lower levels of total phenolics compared with leaves and pods of most native browse trees and shrubs in central Tanzania, such as *Faidherbia albida, Acacia tortilis, Acacia nilotica, Delonix elata* and *Dichrostachys cinerea* (Shayo and Udén, 1999). Phenolic compounds have a capacity to bind to carbohydrates, plant proteins, salivary mucoprotein and gastrointestinal enzymes (Lowry *et al.*, 1996), thereby reducing protein and cell wall digestion (Zucker, 1983). Makkar *et al.* (1989) classified mulberry as low tannin fodder tree.

Table 3. Chemical composition and digestibility of mulberry leaves and bark in central Tanzania.

		Part			
		Leaf	**Bark**	**Leaf**	**Bark**
Composition[1] (% of DM)	**Ash**	14.3	6.1	13.3	6.3
	CP	18.6	7.8	14	8.7
	NDF	24.6	46.8	27.6	44.5
	ADF	20.8	36.9	25.1	38.3
	H	3.8	9.9	2.5	6.2
	ADL	8.1	7.1	-	-
	Cel	12.6	29.7	-	-
	ADIA	2.5	1.1	-	-
IVDMD %		82	60	-	-
IVOMD %		-	-	89	85
Reference		Shayo (1997)		Omar et al. (1998)	

[1] CP = crude protein; NDF = neutral detergent fibre; ADF = acid detergent fibre; H = hemicellulose; ADL = acid detergent lignin, Cel = cellulose; ADIA = acid detergent insoluble ash; IVDMD = *in vitro* dry matter digestibility; IVOMD = *in vitro* organic matter digestibility.

Conclusion

The results have shown that mulberry can survive in semi-arid areas of central Tanzania and possibly other areas of the world with similar climate. Mulberry produces large quantities of highly digestible forage, high in protein. It is encouraging to note that biomass production of edible forage from mulberry is comparable to that of the other introduced browse species. The multi-purpose nature of the mulberry makes it suitable to incorporate in the agro-forestry systems of central Tanzania. However, since mulberry is not a nitrogen fixing plant and since the leaves will be harvested for livestock feeding, recycling of the nitrogen and other nutrients removed from the soil will be necessary. Studies to determine distribution and use of mulberry in the whole country are

encouraged. Also, studies to determine production and reproduction performance of different types and classes of livestock fed mulberry fodder are necessary.

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