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Review on the Nutritive Value of Some Selected *Acacia* Species for Livestock Production in Dryland Areas

Kefyalew Gebeyew[1*], Kibru Beriso[1], Abdo Mohamed[1], G/medhin G/silassie[1], Solomon Melaku[1] and Aniteneh Worku[2]

[1]*Jigjiga University, Collage of Dry Land Agriculture, PO Box 1020, Jigjiga, Ethiopia*

[2]*Debre Markos University, Collage of Agriculture and Natural Resource, PO Box 269, Debre Markos, Ethiopia*

[*]**Corresponding author:** Kefyalew Gebeyew, Jigjiga University, Collage of Dry Land Agriculture, PO Box 1020, Jigjiga, Ethiopia, Tel: +251 924 008 984; E-mail: kefyalewgebeyew@yahoo.com

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Abstract

Nutrition is one of the major constraints to cattle production in the tropics, particularly the lack of protein during the dry season. This review aimed to review the characteristics and nutritional value of some selected *Acacia* species for livestock production in dry land areas. Most browse species investigated showed relatively high fodder value due to high level of crude protein, metabolisable energy, Ca, Mg and K. *Acacia*, a genus of indigenous woody legumes occupy a dominant position in plant communities in semi-arid and arid areas of tropical and subtropical countries. *Acacia* has the ability to rapidly absorb nutrients, particularly nitrogen, and incorporate them into biomass after fire, enabling it to act as a pioneer species. Because of the ability of *Acacia* to fix nitrogen, its nutritive value might be expected to be higher than that of non-leguminous browse species. Although the nutrient contents indicate a high potential for using the foliage of some *Acacia* species as a feedstuff, other constituents also need to be considered. Most *Acacia*s 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 *Acacia*s tested had adequate sodium levels, low level of potassium and sulphur, 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. In conclusion, Utilization of *Acacia* for livestock production could be good feed resource for livestock during feed gaps and drought season.

Keywords: *Acacia*; Livestock; Nutritive; Characteristics

Introduction

Nutrition is one of the major constraints to cattle production in the tropics, particularly the lack of protein during the dry season [1-3]. The problem of feed supply and quality is even more aggravated in arid and semi-arid areas with erratic and unreliable rainfall. Thus, animals in these areas have to survive only on range vegetation that has low nutritive value for most part of the year. The crude protein (CP) content of range vegetation is between 8-12% of dry matter (DM) at the beginning of rainy seasons, but drops to 2-4% in the four to six month dry season [4], leading to prolonged period of under nutrition and malnutrition. Under these circumstances, the most practical supplement would be to use feed resources from locally available legume trees. *Acacia*, a genus of indigenous woody legumes occupy a dominant position in plant communities in semi-arid and arid areas of tropical and subtropical countries [5].

As mentioned in many studies [6-8] the importance of these plants in the arid and semi-arid areas is well recognized throughout the world. The major use of foliage of browse species is as a source of CP. This quality of browse species is most useful during the dry season when most of the range grasses and other herbaceous species dry off [8]. The ability of most browses to remain green in the dry season is attributed to their deep roots that enable them to extract water and nutrients from deep in the soil profile. Moreover, leguminous browse species fix atmospheric nitrogen, and this increases soil fertility that can be utilized by the companion or subsequent crops grown in the area [9], and also contribute to the increased CP content of the foliage of browse species.

Leguminous trees and shrubs are widely used as fodder for livestock in the tropics and subtropics of the world, and only a few of the 900 *Acacia* genus are extensively cultivated for fodder [10]. During the prolonged season of about 8 months in a year especially draught years, *Acacia* species server as source of much need nutrients to domestic herbivores. Several species of *Acacia* are recognized by grazers for their feeding value during drought [11,12]. Studies have indicated that seed pods of some *Acacia* species such as *A. tortilis* and *A. albida* as well as leaves of *A. brevispica* when offered as supplements to poor-quality roughages, give live weight gains comparable with those of livestock fed oilseed cakes and lucern (*Medicago sativa*) [13-15]. The economic value of these species to animal production will depend on when the nutrients are available (i.e. does foliage/seed/pod production match feed gap or drought) and the concentrations of essential nutrients and secondary compounds. The objectives of this review are to review the characteristics and nutritional value of some selected *Acacia* species for livestock production in dry land areas.

General Over View of *Acacia* Species

Characteristics of *Acacia*

The genus *Acacia* is in the Subfamily *Mimosoideae* of the Family *Fabaceae* or *Leguminosae* [16]. Like all legumes, *Acacia*s rely on symbiotic bacteria in their roots for the fixation of atmospheric nitrogen. Species of *Acacia* are found in most environments including the arid zone, sea-coast, sub-alpine areas and rainforest [16]. The 600 species of *Acacia* range in height from 1-3 m shrubs as in *A. iteaphylla* (Flinders Ranges wattle) to trees of 8-15 m as in A. excels (ironwood) and *A. cambagei* (gidgee) and 20-30 m tall trees as in *A. bakeri* (Baker's wattle) and *A. melanoxylon* (black wood). Life spans of *Acacia* species vary widely; *A. melanoxylon* can live for over 100 years, while *A. baileyana* deteriorates after 12-15 years [16,17]. *Acacia* is often found as a pioneer species after fire or other disturbance, and is generally found in the under storey of forests with a higher canopy of Eucalyptus species. In some instances it can be part of the upper canopy, depending on the environment and species [17].

Propagation of *Acacia* is primarily from seed [18,19]. *Acacia* seeds may remain viable in the soil for at least 200 years before the seed coat is compromised. Fire is critical as a germination aid for *Acacia* seeds; without fire, germination can be delayed many years until the extremely hard seed coat is broken. Dispersal of *Acacia* seeds is mainly by mammals, birds and ants. Since most of the dispersal agents for *Acacia* are generalist feeders, for those which consume insects as a component of their diets mimicry must occur; the higher proportion of saturated fatty acids in the arils than in general plant tissues mimics the fatty acid composition typically found in animal prey [20].

Acacia has the ability to rapidly absorb nutrients, particularly nitrogen, and incorporate them into biomass after fire, enabling it to act as a pioneer species. This helps to prevent deterioration of the already low-quality soils from the eroding nature of the environment and also helps to conserve nutrients [18,19]. *Acacia* species are important in the regeneration of forests, and there is concern about the loss of *Acacia* in Eucalyptus forests as a result of grazing by domestic stock and feral herbivores. Declines in abundance of *Acacia* species and in biomass have resulted in declines in those native animal species dependent on *Acacia* as a food source [21].

Use of *Acacia* by livestock

Because of the ability of *Acacia* to fix nitrogen, its nutritive value might be expected to be higher than that of non-leguminous browse species [22]. Instead, *Acacia* tends to be lower in nutritive value, primarily due to the phyllode leaf structure and high tannin content of many species [22,23]. *Acacia* species have either bipinnate (or compound pinnate) leaves (these species are often called 'wattles') or phyllodes (flattened petioles resembling leaves). The phyllode structure tends to be higher in fibre and thus lower in digestibility than pinnate leaves [22].

Vercoe [24] Analyzed the foliage of 29 *Acacia* species found in south-eastern Queensland, though only nine were observed to be browsed by domestic stock. [25] summarized the composition of several *Acacia* species found in the literature, and [26] compared the nutritive value of *A. argrodendron* and *A. cambagei*.

Although these nutrient contents indicate a high potential for using the foliage of some *Acacia* species as a feedstuff, other constituents also need to be considered. *Acacia* foliage and seed pods rarely have toxic effects on animals, but some contain secondary metabolites that may be feeding deterrents. Plant secondary metabolites act as deterrents to insect and fungal and bacterial attack. Secondary metabolites found in *Acacia* species include tannins – both condensed and hydrolysable, oxalates, cyanogens including cyanogenic glycosides, and fluro-acetate. These secondary metabolites are found in the foliage, bark, seeds and even seed pods [17,23].

When ruminants consume high levels of tannins, the tannins form complexes with dietary proteins in the rumen, protecting the protein from microbial attack but also lowering protein availability to the animal [23,25,27]. It has been estimated that forage containing 8% crude protein will provide sufficient ruminal ammonia for resident microbes [25]. Thus the crude protein levels found in *Acacia* (10.7-22.5%) would appear sufficient for domestic ruminants, but because of sometimes high tannin levels, available protein levels in most *Acacia* species may not be adequate for sheep and cattle [25]. Similarly, the majority of sulphur (found as S-containing amino acids) in mulga is probably of limited availability because of the high tannin content [28]. Nevertheless, even with these limitations, ruminants can survive on mulga for substantial periods if supplemented with small amounts of bone meal or meat and bone meal (as a phosphorus source), salt and molasses [17,28]. The molasses contributes energy and sulphur, balancing deficiencies found in mulga [28].

Nutritive value of *Acacia*

Feeding value of any forage is a combination of dry matter availability (and accessibility) and the value of the ingested dry matter for use by the grazing animal (Nutritive value, NV). Variation in voluntary feed intake (VFI) accounts for 50% of the variation in feeding value of forages [29]. As a consequence, any characteristics of the feed which affect intake and the ease of harvesting are critical to the value of the feed for animal production. A number of physical and chemical factors determine both actual intake and utilization.

Description and Distribution

Acacia is a pan-tropical and subtropical genus with species abundant throughout Australia, Asia, Africa and the Americas. They thrive in a diverse range of habitats and environments. Many species are well adapted to the semi-arid and savannah regions but equally others survive in moist forest and riverine areas, tolerating both high pH and waterlogged soils. With such diversity, *Acacia* has considerable potential in a range of livestock and agro forestry systems. In Africa and Australia, some naturally occurring species are important in traditional pastoral and agro pastoral systems, while imported species have become commercially accepted. Trees provide fodder and shade for livestock, improve soil fertility through nitrogen fixation and the production of leaf litter and stabilize soils. *Acacia* species provide edible fruits and seeds, gum arabic and timber for fuel, construction and fencing [30].

In a large genus of 800-900 species [31], classification and nomenclature can be complex, particularly as there have been a number of revisions and attempts to subdivide the genus. Pedley [32] advocated that it be divided into three separate genera, namely *Acacia*, with 200 species best represented in Africa and South America, *Senegalia*, with about 150 species with the same geographical distribution, and *Racosperma*, with about 850 species virtually confined to Australia. While the suggestion may have merit, it has not yet been generally accepted. This text uses the traditional nomenclature adopted by standard flora. Where a name has been changed as a result of a generally accepted revision, the name used in the original reference is listed as a synonym. The names of the African species are those included in the check-list produced by Lock [30] as part of the programmed of the International Legume Database and Information Service (ILDIS).

One widely accepted recent change is the reclassification of *Acacia albida* as *Faidherbia albida*, although [33] stated that the justification for the change was primarily phytochemical. In this publication, for purposes of discussion and comparison, the name *F. albida* is accepted but it is considered as though it had remained within the genus *Acacia*, since it shares many agronomic characteristics with species that have not been reclassified.

Accessibility

The growth architecture of *Acacia* trees and shrubs is likely to limit access by grazing ruminants. Animals can increase intake rate to compensate partially for a reduction in bite size associated with browsing [34], but usually small bite size cannot fully compensate for harvesting difficulties. However, litter fall from *Acacia*s (foliage plus fruit) can be as high as 7 tone/ ha/year, suggest that the quality of litter should be assessed in any selection program. Management by seasonally controlling stocking rates, lopping, or cutting-and carrying are options to increase fodder accessibility to the animal [35].

Digestibility

Digestibility (dry matter digestibility, DMD) of foliage is one of the measures used to describe the nutritive value of foliage. The IVD of *Acacia* foliage has been determined for only a small percentage of the Australian species but available data indicate that it is relatively low, ranging from 28.9% to 55.0%. The lower values have been recorded for the phyllodinous species [36-39]. This relatively low DMD is probably associated with the high lignin content of the cell wall; fiber digestibility is inversely related to lignin content of the fiber [40]. Craig et al. [39] found that digestibility differed between shoots and phyllodes as well as with season and that these differences varied between species.

When the seeds are crushed, the digestibility improved from 12.0% for whole seeds to 53.7% for finely ground seeds. Neutral detergent fibre (NDF) was highest for coarsely ground *A. tortilis* seeds with 47.8% digestibility [41]. The grazing animals on the range swallow these seeds whole a lot of times which means that the seeds pass through the gut poorly digested and the animal derive minimal benefit from the seeds. This can be attributed to the fact that the whole seeds have hard outer covering hence microbial activities in the rumen could not fully utilize the inner seed contents like in crushed seeds.

Where foliage have low digestibility, low Metabolizable energy and high fiber values, then theoretically a grazing animal can still grow by increasing intake. In reality, when IVD falls below 55%, physical limitations on the rate of eating, rate of digestion and passage through the gastrointestinal tract mean that intake is restricted and live weight loss is inevitable [40].

Chemical composition

A selection of chemical compositions of some *Acacia* species is presented in Table 1. Most browse species investigated showed relatively high fodder value due to high level of crude protein (05.84-28.98%), metabolisable energy (04.71-09.39 Mj/Kg), Ca (0.40-03.9%), Mg (0.13-01.37%) and K (0.41-03.5%) [42].

	DM	Ash	CP	NDF	ADF	ADL	NDF-N	ADF-N	TEPH	TET	TCT
	g/kg	g/kg DM					g/kg NDF	g/kg ADF	Mg/g DM		
Fruits											
nubica	936	64	131	481	372	121	2.9	1.6	30.0	24.7	2.4
tortilis	850	41	141	195	169	42	4.7	2.4	88.4	74.4	10.3
brevispics	878	44	131	337	248	88	2.6	2.2	69.3	54.4	11.2
Leaves											
reficiencs	879	91	156	186	111	51	6.6	3.2	237.9	212.9	16.1
senegal	878	77	238	245	141	52	11.3	2.6	188.8	145.4	28.3

Table 1: the chemical composition and phenolic concentration of some selected *Acacia* species.

Protein levels provided by plant analysis are often a misleading indication of protein available to animals consuming the plants. This is partly due to the methods used to determine protein in the plant and partly to the processing and absorption of protein and other nitrogen compounds in the ruminant gastrointestinal tract. Most *Acacia*s examined have adequate crude protein contents for animal production. Again, there is considerable variation between species. *Acacia* tortilis had the highest neutral and acid detergent fibre levels, which were 21.5% higher than that in *A. rhemniana*, the species with lowest NDF, and 25.3%more than in *A. karroo*, the species with the lowest ADF [43].

Mineral concentrations vary significantly between species, ranging from toxic to inadequate for livestock production. The ash in forage has no energy value but the apparent digestibility will be increased if the soluble ash content is high and not accounted for. Craig et al. and Vercoe [39,44] reported phosphorus deficiencies in most *Acacia*s tested, leading to an imbalance in the calcium to phosphorus ratio in foliage. Similarly, for most species the levels of potassium, sodium and sulphur were low [44], but [39] found that most *Acacia*s tested had adequate sodium levels. In the latter case, differences between species should be treated with caution, as the plant material was collected from the wild. Such differences may reflect differences in soil and growing conditions more than differences between species. In a study of the mineral composition of foliage of some species of *Acacia*, Vercoe [44] found that copper was at levels that may be toxic to sheep, but copper contamination of samples could not be ruled out. Other minerals (Table 2) were at acceptable levels [45].

	Ca	Mg	P	S	Mn	Mo	Zn	Co	Cu	Fe	Se
	g/kg DM						mg/kg DM				
Fruits											
Nubica	936	64	131	481	372	121	2.9	1.6	30.0	24.7	2.4
Tortilis	850	41	141	195	169	42	4.7	2.4	88.4	74.4	10.3
Brevispics	878	44	131	337	248	88	2.6	2.2	69.3	54.4	11.2
Leaves											
Reficiencs	879	91	156	186	111	51	6.6	3.2	237.9	212.9	16.1
Senegal	878	77	238	245	141	52	11.3	2.6	188.8	145.4	28.3
SEM	1.2	0.11	0.14	0.68	7.0	2.2	1.2	0.22	7.3	74.1	5.0
LSD (P<o.05)	3.9	0.29	0.35	1.75	18.1	5.7	3.1	0.56	18.8	190.6	12.9

Table 2: Mineral concentration of some selected *Acacia* species.

According to Aganga [41] *Acacia* species are very important to livestock nutrition. The Ca content for all the evaluated seeds are lower than those reported by Terry et al. [46] while the Mg contents fall below adequate levels reported by McDowell [47] for normal growth of beef cattle. *Acacia* seeds contained low levels of Na.

Conclusion

The chemical composition of *Acacia* is an indication of the potential of *Acacia* as feed supplement for livestock production. Utilization of *Acacia* for livestock production could be good feed resource for livestock during feed gaps and drought season. During the prolong season of about eight months in a years, *Acacia* species server as source of much nutrient to domestic herbivores.

Competing interest: The authors declare that they have no competing interest

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