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Biomass Yields and Nutritive Composition of *Leucaena* Varieties in Irrigated Lowland of Dassench Woreda of South Omo, South-Western Ethiopia

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ABSTRACT

The shortage in livestock feeds is among the factors affecting the livestock production in South Omo. This feed shortage stretches to increase unproductive and low productive performance of livestock in the study areas. Thus, present finding intended to evaluate the biomass yields and nutritive values of *Leucaena* varieties under surface irrigation at Dassench Woreda. The Sermemiret Kebele from Dassench Woreda was nominated for on-farm experimental trial with vigorous connections with Woreda pastoral office experts. The *Leucaena* varieties viz. DZ-0032, DZ-321, DZ-dismounts, DZ-235 and DZ-032 were assessed in a randomized complete block design with three replicates per variety. The biomass yields, plant height, branches per plant and nutritive values were analyzed by using the General Linear Model (GLM) and Least Significance Difference (LSD) was used for mean comparison. The DZ-321 variety yielded higher ($p<0.05$) biomass yields (31.37 tons/ha), whereas the DZ-dismounts variety yielded lower biomass yields (11.88 tons/ha). The DZ-032 variety contained higher ($p<0.05$) crude protein (233.5g/kg, DM), whereas the DZ-dismounts and DZ-321 varieties contained lower ($p<0.001$) crude protein (144.4 g/kg, DM and 148.5g/kg, DM), respectively. Thus, it was concluded that the agro-pastoralists and pastoralists could enhance the feed availability for livestock by planting DZ-321 *Leucaena* variety for higher biomass yields.

Introduction

"The overall productive and reproductive performances of livestock in Ethiopia are generally very low" [1-3]. Likewise, the poor-quality feeds and inadequate supply of feed biomass from the grazing-land (natural-pasture) to livestock in South Omo Zone are one of the important element that are contributing to low outputs (milk, meat and growth rates) from the livestock [4,5]. It seems that the nutritive values generated from the grazing-lands are seriously affected by dynamics of pasture-forages [5,6]. Hence, nutritive values from the extensive-grazing-lands do not realize the crude protein and energy demands of livestock. "This is activating to escalation great slow growth rates, high mortality, longer calving intervals and substantial weight loss" [7,8].

The supplementary feeding system is the addition of some feeds that are rich with vital nutrients to low-quality-forage to improve the intake and digestibility of low-quality forages aimed for higher outputs from animals. The evaluating and familiarizing of locally adaptable improved forages-crops to supplement the extensive-pasture-grazing system for pastoral and agro-pastoral areas is only the way to engulf feed shortages [4,5]. The *Leucaena* species is one of legume fodder trees, which is evergreen, highly branched and have a fast-growing potential, which grows up to a height of 5m to 20m [9]. It well adapted and better yielded in a wide range of rainfall environments which ranging from 650-3,000mm with warm temperatures ranging from 25°C to 30°C [10].

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The average dry biomass yields of *Leucaena* species are ranges from 3-30 tons/ha depending on soil, temperature, and moisture conditions [9]. The dried leaf of *Leucaena* species contained crude protein and metabolizable energy values which ranging from (230-288.6g/kg DM) and (10.27MJ/kg DM), respectively [11,12]. The sheep groups fed on basal diet of grass-hay and supplemented with diets contained dried *Leucaena* leaves with inclusion levels, ranging from 25-50%, showed higher daily feed intake and weight gain over non-supplemented sheep group [11]. "The *Leucaena* leaves meal or fresh leaves can also replace concentrate diets, since it increases total daily dry matter and protein intake, and thus improving growth rate of animals" [13,14]. Also, it was reported that the *Leucaena* foliage inclusion levels between 500g/kg, DM and 750g/kg, DM can be replaced concentrate diet without adversely affecting the growth and milk production performances in goats [15,16]. However, with this notable potential of species, different *Leucaena* varieties have not been evaluated under irrigated condition for biomass yields and nutritive values. Thus, this study aimed to evaluate the biomass yields and nutritive values of *Leucaena* varieties for the drought prone areas in South Omo Zone.

Materials and Methods

Experimental Site

On-farm evaluation was carried out from June-December 2019 main planting season. The Sermemiret has laid at 5014'N latitude and 36044'E longitude, and far about 230km from Jinka town (Capital city of South Omo Zone). The area has annual temperature and average rainfall which ranging from the 25-40^{o}C and 350-600mm, respectively, with erratic rainfall distribution. The altitude of the study area is in the range of 350m to 900m above sea level and soil of planting site is alluvial soil.

Agro-Pastoral Research Extension Group (APREG) Formation

One APREG that comprised about 25 Agro-pastoralists was established with vigorous envelopments of experts from Woreda Livestock and Fisher Development Office by considering irrigation-access, interest and irrigation capabilities of trial agro-pastoralists. The selected trial Agro-pastoralists and experts were trained on forage agronomy and irrigation water management techniques.

Experimental Design and Variety

The five *Leucaena* varieties such as DZ-0032, DZ-321, DZ-dismounts, DZ-235 and DZ-032 were obtained from DZARC. A plot area sized 4m by 3m = 12m having about four rows and two seed per hole planted after treated seeds in water boiled at100^{0}C for one minute to break dormancy of seeds. The spaces between plots and plant were 1m, respectively and the total area of trial site was 12x26m (312m^2). Thus, a total of about fifteen plots which each measured 12m2 sized were used in the present study. The randomized completed block design comprising three repetitions each variety was used and plots in each block were randomly assigned per variety. The 3kg/ha seeding rate were used without fertilizer application [17]. The surface irrigation was used, and all the plots were irrigated uniformly as per the intended irrigation schedule [17].

Experimental Site and Data Collection

The trial site was always kept weed-free by hand weeding and hoeing, and agronomic data like plant height and branches per plant were recorded when plants was at 50% blooming stages (28 weeks after planting) by taking nine plants from middle of three rows per plot. The average plant height was recorded from ground to the pitch of the main stem. To measure the biomass yields at 28 weeks, all leaves and sprouts were contemplated from the three collected middle row per plot, and fresh sample was recorded in field by using spring weight balance, and 500g sub-sample per plot was brought to laboratory and cut into small pieces. Then 300g of sub-sampled sample was allocated into oven dried set at 105oc temperature for 24hours for biomass yields determination [18].

$$Dry\ Matter\ Yield = (t\ ha - 1) = TFW \times (\frac{DWss}{HA} \times FWss) \times 10$$

Where TFW = total fresh weight kg/plot, DWss= dry weight of sub-sample in grams, FWss = fresh weight of sub-sample in grams, HA = Harvest plot area in square meters and 10 is a constant for conversion of yields in kg/m to t/ha. The BPP for each variety was calculated by counting all main braches on sampled trees and average of sampled branches was considered.

Chemical Analysis

The nutritive values analysis was done at DBARC. Three leaves-samples of each variety were put into oven dried which set at 65°C for 48h and crushed to pass comprehensive 1mm sieve size for chemical analysis. The laboratory analysis was conducted for different nutritive values (DM, Ash, CP, NDF and ADF). DM, CP and ash were investigated by "technique of [19]". The NDF value was evaluated by [20] while the ADF value was evaluated by process of [21].

Data Analysis

The data such as plant height, branches per plant, biomass yields, and nutritive values were subjected to analysis of variances using the Generalize Linear Model (GLM) [22]. The significant differences among the means of varieties were declared at $p<0.05$ and means were separated using LSD test with following model:

$Yijk = \mu + Vi + eijk$, where, yijk = all dependent variables; μ = overall mean; Vi = the effect of variety; and eijk = random error.

Results and Discussion

Biomass Yields and Agronomic Parameters

The result on biomass yield, plant height and branches per plant of *Leucaena* varieties at Dassench Woreda are presented in Table 1. The result revealed that DZ-321 variety yielded higher (p<0.05) biomass yields than DZ-dismounts variety, but the biomass yield was similar (p>0.05) to DZ-032 and DZ-235. However, the biomass yield was not significantly (p>0.05) varied among DZ-032, DZ-0032 and DZ-235 varieties. Moreover, the DZ-321 had taller plant height than DZ-032, DZ-0032, DZ-235 and DZ-dismounths, and but it was not significant (p>0.05) varied among the varieties. Relating to branches per plant, the more (p<0.05) branches per plant were recorded from DZ-0032 variety than DZ-235 variety, but plant height was similar (p>0.05) among the DZ-dismounths, DZ-321 and DZ-032 varieties.

Table 1: Biomass yields, plant height and branches per plant of Leucaena varieties that grown at Dassench Woreda in 2019 planting season.

Variety	Biomass Yield (t ha^{-1})	Plant Height (cm)	Branches Per Plant
DZ-032	19.37^{ab}	355.2	30.07^{ab}
DZ-321	31.37^{a}	404.53	38.06^{ab}
DZ-dismounts	11.88^{b}	331.67	33.80^{ab}
DZ-235	20.05^{ab}	349.67	27.73^{b}
DZ-0032	15.72^{b}	348.2	43.47^{a}
SEM	6.01	51.54	6.08
LSD	13.86	118.86	14.02

Note: (Means with the different letters (a, b) in across column for biomass yields, plant height, branches per plant at 50 percent blooming periods are not similar at p<0.05; SEM=Standard error of mean).

The reason for higher biomass yields for DZ-321 variety was justified that variability genomic potential. In supports to result from the present study, the studies stated by [23] and [24] were showed that the difference in biomass yields among the forage crops is ascribed due to variances in hereditary potential of forage species. Moreover, "biomass yields variability for forage species could be reported due to varietal or biological potential" [25]. "These effects have been widely described for legumes in general [26] and *Leucaena* variety in particular" [27]. The biomass yields obtained from present study for all varieties were similar to reported average biomass yields which ranges from 10-30 tons/ha under well fertile soil [28]. Also, similar biomass yields were perceived from this study to reported biomass yields of 2-13 tons/ha in Australia, 14-16 tons/ha, in Brazil, 15-50 tons/ ha, in New Guinea 15-19 tons/ha, in Taiwan from 3-21 tons/ha, in Virgin Islands [29]. However, the biomass yields from this study were higher than previously reported values range from 1.5-10tons/ha under tropical condition [17]. The lower branches per plant for DZ-235 variety over other varieties are due to lower varietal potential of variety. Similar result to present study was reported for branch per plant by Minson and Hegarty [27], which is indicating that there are variations in branches per plant among species, varieties and eco-types of the *Leucaena* species.

Nutritive Values

The nutritive values of *Leucaena* varieties in Dassench Wored are presented in Table 2. The *Leucaena* DZ-032 and DZ-321 varieties had higher (p<0.05) crude protein (CP) content than DZ-235 variety, but the ash content was similar (p>0.05) to DZ-0032 variety. Moreover, the DZ-032 contained higher (p<0.05) CP content than DZ-321, DZ-dismounths, DZ-235 and DZ-0032 varieties. However, the DZ-321 and DZ- dismounts varieties had lower (p<0.05) CP content compared to DZ-235 and DZ-0032 varieties, but the CP content was in significant (p>0.05) between DZ-321 and DZ-dismounts varieties. Similarly, DZ-032 variety had low (p<0.05) NDF and ADF than DZ-321, DZ-dismounths, DZ-235 and DZ-0032 varieties, but the DZ-321, DZ-235 and DZ-dismounths were insignificant (p>0.05) for NDF and ADF content. The higher CP content and lower NDF and ADF for variety DZ-032 in study area is due to "higher-genetic-potential which might be accounted to accumulate the high nitrogen contents from the given environments". The result on CP content obtained from our study for DZ-032 *Leucaena* variety was in agreement with the previously reported value of (23%) by Juma, et al. [30], while the CP content values form this study for all *Leucaena* varieties was lower than previously reported values of 28.86% and 25.7%, respectively, [12,31] for the dried leaf *Leucaena* species. The protein content of all *Leucaena* varieties from this study is quite adequate to realize the smallest requirement of ruminant-animals (8–12%) which is suggested by Dhok, et al. [32]. The deficiency of protein can be a major limitation in animal diet that affects the intake and utilization of most tropical forages by animals. Thus, it was suggested that "the minimum CP content required for lactation and growth in cattle is 150g/kg, DM [33], whereas the NRC [34] recommended the minimum requirement of CP is 75g/kg, DM for adequate rumen function in ruminant animals. Moreover, "the feeds sources that containing less than 60g/kg, DM are considered as CP deficient and such feeds cannot provide the minimum level of ammonia (50-80mg^{-l}) required for maximum microbial growth in the rumen". Conversely, in the study district the CP content of the range forages were can not provide adequate CP to meet the requirements of the ruminant animal especially during dry period's higher fibers and lower crude protein contents from our study for DZ-321 and DZ dismounths varieties might be due to environmental factors. "The soluble carbohydrate contents in neutral detergent do not depend only on species, but also on their responses to the environment" [35]. Hence, the CP content reported from our study is higher than minimum recommended level for ruminant production in pastoral and Agro-pastoral production systems. The result from this study is also presented a good opportunity for pastoral and Agro-pastoral communities to overcome the CP deficiency if the communities are participated voluntary to supplement their animals by planting the *Leunaena* species at farmyard and around homesteads by using irrigation or rain fed. Besides, the physical characteristics of the samples, the responses to the environmental conditions, the genetic-factors and the differences in the phonological development of these eco-types could have influenced [36]. In this respect, "the great diversity in the *Leucaena* genus exists in the content of NDF (21.5-56.8%) and the cellular content [37]". The NDF and ADF values obtained from this study were higher than previously reported values which ranged from 31.70-35.74% and 18.20-22.60%, respectively for NDF and ADF by different scholars [31,38,39].

Table 2: Nutritive values of Leucaena varieties grown-up under irrigation at Dassench Woreda in 2019 planting season.

Variety	DM%	Ash%	CP (g kg^{-1})	NDF (g kg^{-1})	ADF (g kg^{-1})
DZ-032	90	10.03^{a}	233.50^{a}	479.70^{b}	318^{b}
DZ-321	89.97	10.10^{a}	148.70^{c}	569.20^{a}	432.40^{a}
DZ-dismounts	90.41	7.87b^{c}	144.40^{c}	537.60^{a}	428.40^{a}
DZ-235	91	6.07^{c}	185.40^{b}	557.10^{a}	415.10^{a}
DZ-0032	90.33	8.73^{ab}	188.30^{b}	484.80^{b}	306.90^{b}
SEM	1.48	0.83	0.73	2.26	1.19
LSD	3.41	1.91	1.69	5.23	2.74

Note: (Means with the different letter (a, b, c) in across column for nutritive values are significantly differed at p<0.05 at 50 percent blooming periods; DM%= Dry matter percent, Ash%= Ash Percentage; CP= Crude Protein; NDF = Neutral Detergent Fiber; ADF= Acid Detergent Fiber; SEM= Standard error of mean).

Conclusion

The DZ-321 variety gave higher biomass yields, while DZ-dismounts variety gave the lower biomass yields. However, the DZ-032 variety had higher CP and lower fibers (NDF and ADF), while DZ-dismounts and DZ-321 varieties were giving the lower CP. Thus, it can be concluded that herders in study areas can be planted DZ-321 variety for higher biomass yields, while DZ-032 variety for higher CP content.

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