International Journal of Livestock Research, Vol. 13 (7) Jul' 2023
http://www.ijlr.org
eISSN: 2277-1964

Original Research

Foliage Yield and Chemical Composition of *Yushania alpina* as Livestock Feed in Bonke District, Gamo Zone, Southern Ethiopia

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How to cite this paper: Abeje, A., & Kore, A. (2023). Foliage Yield and Chemical Composition of Yushania alpina as Livestock Feed in Bonke district, Gamo Zone, Southern Ethiopia. *International Journal of Livestock Research*, 13 (7), 46-51.

Received : Apr 04, 2023
Accepted : Jul 05, 2023
Published : Jul 31, 2023

Abstract

During the dry season, when plant growth is highly suppressed, shortage of fodder availability reduces growth of livestock. In many parts of Gamo zone including the study area, lopping and feeding tree foliage is becoming a common practice to maintain sustainable productivity in livestock or to overcome the fodder deficit. However, knowledge optimal age of harvest for foliage biomass yield and their nutritional content along with their digestibility with regard to bamboo tree foliage is limited. Therefore; the present study was carried out to evaluate foliage yield and chemical composition of Yushania alpina at different ages in Bonke district. Samples were collected from three 10m x10m plots prepared at the middle of well-established bamboo stands. Bamboo culms within each plot were grouped into three age classes (1-2years, 3-4 years and above 4years). Foliages from three different age classes were collected to determine yield per hectare. Samples of bamboo foliage from each age-class were dried, finely ground and analyzed for nutrients. Parameters tested were Moisture Content, Dry Mater, Ash Content, Organic Matter, Crude Protein, Neutral Detergent Fiber, Acid Detergent Fiber, Acid Detergent Lignin, Cellulose and Hemi-cellulose. The results showed significant difference (P<0.05) between ages for foliage yield. The result of chemical composition also showed significantly highest DM (94.6), OM (88.52), CP (15.42) and (NDF (70.47) in culm ages of 3-4 years. However, Highest Ash content (15.49), ADF (48.47) AND ADL (12.48) was obtained from ages above 4 years culm. The study concluded that foliages of 3-4 years old culms have good organic matter and crude protein and can be used for animal feed supplementation especially in dry seasons where there is a scarcity of fodder.

Keywords: Biomass, Fodder, Foliage, Nutrient, Stand, Yield.

Introduction

Livestock production plays an important role in Ethiopian economy providing source of livelihoods to 85% of the population, and contributing 47.687 % of the total Agricultural Gross domestic product (GDP), as well as 10.6% to the foreign exchange earnings (Behnke 2010). However, productivity is quite low (Shenkute et al 2012). Feed shortage both in quality and quantity is the commonly cited problem in the livestock sector (Gizaw et al 2012; Mekonnen et al 2014; Mekasha et al 2014). As most livestock are kept on a free-range system, forage of fair nutritive value is normally scarce in the dry season due to prolonged droughts, continuous over-grazing and lack of range improvement interventions (Konlan et al 2016). As a result, highly palatable and productive perennial grasses, legumes and herb species have been replaced by unpalatable, low quality annual species, with a concomitant loss of soil fertility (Estell et al 2014). One potential way for increasing the quality and availability of feeds for smallholder ruminant animals in the dry season may be through the use of fodder trees and shrub.

Cultivating bamboo is been a tradition in Gamo highlands for multiple uses, mainly as construction material, furniture, fodder, ornamental garden planting, and soil conservation. However, knowledge on optimal age of harvest for foliage biomass yield and their nutritional content along with their digestibility is not much known. Thus, the current study was undertaken to investigate the foliage biomass yield and chemical composition of highland bamboo at different age classes in Bonke district, Southern Ethiopia.

Methodology

Description of the Study Area

The study was conducted in in Bonke district, Southern Ethiopia. The district has a geographical location of between 6° 2' 60N and 37° 19' 60E latitude and longitude respectively. The annual rainfall ranges from 1000 mm to 1400 mm; The minimum, maximum, and mean annual temperature of the area are 12°c,19°c and 16°c respectively (CSA AMB, 2021). Mixed crop-livestock farming is typical for the district. The dominant trees of the area include *Acacia docurrens*, *Hagenia abyssinica*, *Croton macrostachyus*, *Erythrina brucei*, *Eucalyptus species*, *Arundinaria alpine* and Vernonia species. Apple (*Malus domestica*) is a dominant fruit tree in the site. The main annual crops grown are barely, wheat and potato. The dominant livestock in study district are sheep, cattle, equines and chicken (BWANRO, 2020).

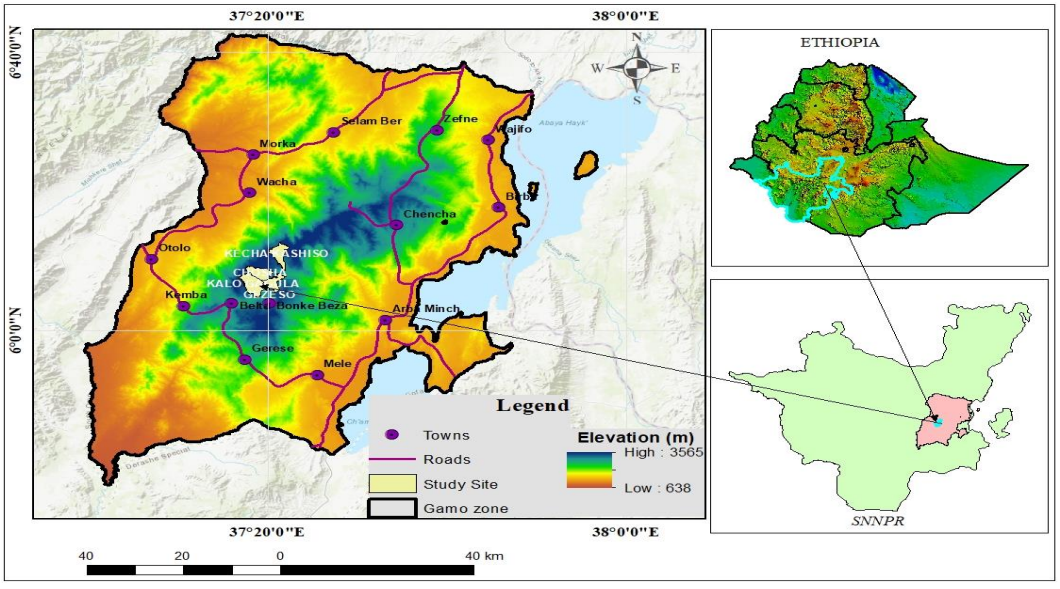

Figure 1: Map of the study area (Aman Abeje, 2021).

Sampling Procedure and Sample Preparation

Prior to the research work, preliminary survey and field observations was conducted. Based on the preliminary survey, four kebeles (Kecha Kashaso, Chosha, Gezeso and Kallo Gagula) which were on bamboo production

potential were purposively selected for the study based on bamboo production potential. Well-established bamboo stands were identified and delineated from each kebeles. Three10m x10m plots, a total of twelve plots were established at the middle of the selected bamboo stands. All one year and above bamboo culms were counted, and grouped into three age-classes: 1-2years, 3-4 years and above 4years. Only one culm was made to fall from each age-class and plot (i.e.3x3x4=36 culms). The fallen culms were carefully separated in to culm, branch and foliage parts.

Figure 2: Sample preparation at different ages of bamboo culm (Aman Abeje, 2021).

Foliage Biomass yield Estimation

Foliage biomass of bamboo was assessed from fallen culms of each age category. Harvested foliages from fallen culms of varying age classes weighed separately from different plots to determine the yield of foliage in each age-class category. The mean foliage yield multiplied by the mean culm frequency per plot to obtain mean foliage yield of each age-class per plot, another converted to per hectare.

Analysis of Foliage Chemical Composition

Samples were analyzed at Arba Minch University, College of Natural Science, Department of Chemistry. The dry matter (DM) was determined by air drying under shade and then oven drying the sample at 65°C for 24 hours till constant weight was obtained. The amount of organic matter (OM) in the foliage was determined by reducing the amount of dry matter from the amount of inorganic matter (crude ash). Total ash was analyzed as per AOAC (2005) procedure number (942.05). Crude protein (CP) content was estimated by the automated Kjeldahl technique 976.05. The percentage of leaf nitrogen found using the Kjeldahl apparatus was multiplied with the factor 6.25 (CP = N × 6.25) to obtain the crude protein. Natural detergent fiber (NDF) was determined using techniques described by Van Soest et al (1991). Acid detergent fiber (ADF) and acid detergent lignin (ADL) were analyzed by AOAC procedure number (973.18).

Data Analysis

Data obtained were subjected to Analysis of Variance (ANOVA) using the General Linear Model (GLM) with SAS statistical software version 9.0.Significant differences among treatment means were tested using Least Significant Difference (LSD).

Results and Discussion

Foliage Yield Potential of Bamboo (kg/ha)

Results revealed that mean foliage yield significantly affected ($p<0.05$)) by age of bamboo (Table 1). The highest mean foliage yield (5085.49kg/ha) was recorded at 3-4year ages of bamboo. The possible reason might be high frequency of bamboo culms at 3-4years age (2717 culms/ha) as compared to 1-2year (2445 culms/ha) and >4years

(2210 culms/ha). Younger culms cannot fully grow their leaves, and also harvesting and utilization of old aged culms were economically and ecologically sound than younger culms. Therefore, culms from one to two years old onwards produce dense foliage biomass for supplementing feed particularly in the dry season.

Table 1*:* Estimated foliage biomass yield (kg/ha) influenced by age of bamboo

Age class	Mean number of culms/ha	Mean foliage yield (kg/ha)
1-2year	2445	4652.16±14.99b
3-4year	2717	5085.49±47.40a
>4years	2210	4358.05±11.16c

Means followed by different superscripts are significantly different at p<0.05.

Chemical Composition

The chemical composition of the bamboo foliage investigated in the current study is presented in Table 2.The dry matter (DM) contents of 3-4years age culms were significantly highest (94.64%) than other age classes. Our result in the dry matter content is higher than the study report for *Ficus sur* (23.52%) by Omoniyi et al (2013), and for bamboo (ranging from 45.2% to 65.4%) by Bhandari et al (2015).

The study revealed a significant difference (P<0.0001) in ash content among the ages of bamboo foliage (Table 2). The highest ash content (15.49%) obtained from above 4years old bamboo culms and the lowest ash content (11.48%) recorded from 2-3 years old culms. Our result in ash content is much higher than ash content values (1.98 and 0.039%) for *T. brownii* and *D. giganteus* respectively, reported by Agatemor and Ukhun (2006).

Table 2: Chemical composition of bamboo foliage at Bonke district

	Parameters						
Age class	**DM**	**Ash**	**OM**	**CP**	**NDF**	**ADF**	**ADL**
1-2years	89.65±0.10^{c}	13.51±0.08^{b}	86.49±0.08^{b}	13.43±0.12^{b}	70.45±0.10^{a}	45.53±0.13^{b}	8.65±0.09^{c}
3-4years	94.64±0.08^{a}	11.48±0.08^{c}	88.52±0.08^{a}	15.42±0.12^{a}	70.47±0.09^{a}	45.52±0.11^{b}	9.54±0.11^{b}
>4years	91.71±0.12^{b}	15.49±0.11^{a}	84.52±0.11^{c}	11.61±0.12^{c}	64.51±0.12^{b}	48.47±0.09^{a}	12.48±0.10^{a}
P-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
LSD	0.32	0.27	0.27	0.37	0.29	0.33	0.31

Means within the same column having different superscripts are significantly different at p<0.05.Dry Matter; OM=Organic Matter; CP=Crude Protein.

The organic matter contents of the bamboo foliages significantly (P<0.0001) affected by age, and range from 84.52% to 88.52%. The lower mean value of OM at culms above 4years age is related to the higher proportion of Ash content in the dry matter. Our result was comparable Desalegne et al (2019) who reported 85.01% and 85.80% for the introduced bamboo leaf samples respectively from Jimma and Chagni areas of Ethiopia.

Crude protein of bamboo foliages significantly (P<0.0001) affected, and the highest crude protein (15.42%) recorded from 3-4years old culms and lowest values (11.61%) obtained from above 4-year culms. Our results on mean crud protein value is comparable to Andriarimalala et al (2019) who reported crude protein contents of bamboo leaves averaging 12.50 %. Bhandari et al (2015) also reported crude protein contents of bamboo leaves averaging 12.3 % and ranging from 8.4 % to 17.1 %, which are in agreement to our results.

There showed significant difference (P<0.0001) in NDF and ADF content among ages of the bamboo foliages (Table 2).According to Bhandari et al(2015), NDF is strongly related to the feed voluntary intake and the availability of net energy from digestible energy. The lowest NDF content (64.51%) was recorded at above 4years old culms. Our results of NDF was lower than that reported by Andriarimalala et al (2019), which averaging 76.20 %.

Acid detergent fiber (ADF) in the current study is higher than the values (16.00%, 16.00% and 17.00%) reported by Uzman et al. (2011) for the browse trees *Morus alba*, *Acacia nilotica* and *Ziziphus jujube* leaves, respectively.

Significantly different (p<0.0001) Acid Detergent Lignin concentration was recorded by three age of bamboo

foliages. The highest value of ADL was recorded above 4years old bamboo culms (12.48%).The possible reason might be lignified leaves of matured culms.

Conclusion and Recommendation

The study evaluated foliage yield and chemical composition of *Y. alpina* in Bonke district, southern Ethiopia. The result showed higher foliage yield within 3-4year old bamboo culms than other tested culms ages. Bamboo leaves rich in organic matter and crude protein. Study revealed that the age bamboo culms significantly affected Dry Mater, Ash Content, Organic Matter Content, Crude Protein, Neutral Detergent Fiber, Acid Detergent Fiber and Acid Detergent Lignin. Three to four years is the optimal age to harvest bamboo foliages, in order to get a moderate fibre content and improve intake and digestibility. However, when the age of bamboo is above four years, its leaves became lignified, and livestock pick off young, less lignified leafy shoots. It is important to identify. The study recommends smallholder farmers can integrate bamboo cultivation in their forage system to enhance the feed sufficiency and diversity, in order to improve the animal productivity thereby ensuring food security. Obviously, livestock performance can be measured in terms of live-weight gain, milk production, and reproductive performance. Therefore, feeding trials with small ruminants should be done to evaluate performance.

Acknowledgment

We are grateful to Arba Minch University for providing financial support to the accomplishment of the research work. Our Special thanks go also to Gamo Zone, Bonke District administrators, development agents and the community for their imaginative opinions and cooperation during the field work.

Contribution by Authors

Equal contribution

Conflict of Interests

There is no conflict of interest.

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