

Biomass Yield, Botanical Composition and Nutrient Content of Major Grazing Resources of Buffalo (*Syncerus caffer*) in Dhati Walal National Park, Western Ethiopia

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Abstract: A study on biomass yield, botanical composition and nutrient content of major grazing feed resources of Buffaloes (*S. caffer*) was carried out in Dhati Walal National Park, Western Ethiopia. Representative samples were collected using quadrant and analyzed for their biomass yield, botanical composition and nutrient contents using Statistical Package for Social Sciences (SPSS), version 21. During the current study, nine edible and five most preferred forage species were identified. The preferred forages species were *C. papyrus* (38%), *C. latifolius* (23%), *H. flipendula* (17%), *C. aterrimus* (13%) and *S. caespitosus* (9%). The estimated biomass yield for major herbaceous plants, without including less dominant ones, was estimated to be 272.02.5 tons/900km² of grassland per harvest. This was equivalent to 3.02 tons/ha per harvest. The buffaloes stocking rate was equivalent to 1.025 TLU per hectare. The crude protein and fiber contents of the herbaceous plants observed were in a wide range (5.69-23.5%); NDF (40.68- 69.45%), ADF (29.2-56.8%) and ADL (9.9-14.5%). The herbaceous plant *C. aterrimus* leaves contained highest crude protein (23.5%) and lowest fiber and lignin contents. Hence it was identified as the most potential plant species in the park in terms of nutrient content.

Key words: Buffalo • Dhati Walal • Grazing resources • Nutritive evaluation • Park

INTRODUCTION

In Ethiopia, the profound geological history, broad latitudinal spread and diverse altitudinal ranges provide remarkable broad ecological regions that are composed of high mammalian diversity [1, 2]. Among these, most of the large mammals such as buffalo inhabit the southern and western lowland ecosystems of the country [3].

Ethiopia has so far established several protected areas, which cover about 16.4% of the total area of the country [4]. These areas have both direct and indirect values. The direct values include recreation, ecotourism and employment. In terms of environmental services, protected areas play pivotal roles in providing ecological functions such as watershed protection, soil stabilization and erosion control, provision of clean water and associated filtration and storage functions, climate stabilization and carbon sequestration. One of such protected areas is Dhati Walal National Park.

Reports indicate that protected areas that are managed by Ethiopian Wildlife Conservation Authority (EWCA) have an economic values estimated at 1.5 billion USD per year [5]. This indicates that protected wildlife parks do have such important economic roles to the nations. However, it is uncommon to periodically monitor the status of the grazing resources in such protected areas in Ethiopia. Feeds are the main input in domestic and wild animals' reproduction.

Domestic animals are usually supplemented with concentrate diets in cases where their basal diet is insufficient in supporting optimum productivity. In contrary to this, wild animals such as buffaloes protected in the parks like Dhati Walal National park, are dependent only on the grazing and browse resources in the park. Like any other domestic species, wild animals have particular requirements for nutrients at specific levels and ratios, at each stage of their lives. These requirements differ for growing, dry, pregnant and lactating animals. Nutritive

quality of range varies from area to others, between seasons and growing stages. The potential of any feed to support animal production depends on the quality consumed by the animal to the extent the consumed feed meets energy, protein, minerals and vitamin requirement of animals [6]. There were no any research results indicating, species composition, yield and nutritional status of grazing feed resources in the park. In such conditions, close follow up and evaluation of the productivity and nutrient content of such grazing resources of buffaloes is highly important.

The current study, therefore, was conducted in the Dhati Walal National Park with following objectives.

- To investigate and determine biomass productivity and nutrient content of major grazing feed resources of buffalo available in the Park,
- To identify the botanical compositions of grazing resources of buffaloes in the park and
- To describe the stocking rates of buffaloes in the park

MATERIALS AND METHODS

The Study Area: The study was conducted in Dhati Walal National Park which is located on the border between West Wollega and Kellem Wollega Zones of Oromia Regional State, Western Ethiopia. The park is situated at a distance of 645km from Addis Ababa to the West direction. The area is located between 67° 55' and 72° 45' E longitude and between 10° 05' and 10° 51' N latitude [7].

The minimum and maximum rainfall of the area is reported as 1200 mm and 1500 mm, respectively. While the minimum and maximum temperature values recorded were 20°C and 25°C, respectively. The maximum mean temperature record was during March and April and lower values recorded were observed from July to August [8].

Sample Collection Procedures: During field study, dungs and foot prints of the buffaloes observed were used to estimate areas where buffaloes frequently graze. From the field observation all necessary points were recorded whenever it was felt relevant for the study. After identifying all the major feed resources consumed by buffaloes they were taken for further analyses.

Feed Sample Harvesting and Preparation: Among several techniques of feed analyses, direct observation method was employed using a pair of binoculars and unaided vision on the bases of distance and habitat types during

the daylight hours. To quantify the vegetation in the feeding patch, backtracking method was used, where the diet of the animal is identified and quantified after the animals have moved from the grazing patch.

With the aid of foot marks and color of the part where there is the bite on the plant, one can identify grass species liked or consumed. To minimize the impact on the herd's behavior, sampling of the patches was not undertaken immediately as the herd had finished feeding and rather often returning later during the day, or in the case of late afternoon observations or the next morning. Data was collected only on mixed herds and the bachelors. Direct observation of a particular herd was performed sequentially and feeding sites of each herd were observed. Finally the samples were collected and organized for further analysis.

Forage Biomass Yield Estimation: In determination of species identification and biomass yield of the native pasture in the park, calculation was done following appropriate method irrespective of their nature. Accordingly, 0.5m x 0.5m quadrant was randomly thrown at different places in the grassland areas where buffaloes frequently graze. All the species within the quadrant were mowed together, weeds removed and edible components were weighed in all sampled areas and bulked together and average yield was calculated. Then after the average biomass yield was (On dry mater basis) obtained per quadrant, it was converted into the total biomass yield per total area of grassland in the park [9].

Identification of Species Composition: Each grass species within the quadrant was identified, sorted and recorded. Percentage of the plants was calculated for the major grass species selected by buffaloes to its relative availability.

Estimation of Stocking Rate: Stocking rate is defined as the number of animals kept on a given amount of land over a certain period of time. Stocking rate is generally expressed as animal units per unit of land area [10]. To determine stocking rate first all herbivores in the park were identified and estimated in number. All estimated number of the herbivores was multiplied to their average weight to get total weight of herbivore. The total weight of all herbivores was divided by 250kg, which is one tropical livestock unit (TLU) to get uniform measure of the animals. The weight of the buffaloes in the park also estimated by experienced staff of the park, particularly those who are looking after the buffaloes for protecting

the wild animals from hunting in the park. Finally stocking rate of the park was calculated by dividing the total TLU of the herbivores in the park to total land the buffaloes used to graze.

$$\text{Stocking Rate} = \frac{\text{Total TLU}}{\text{Grazable Land Area}}$$

To determine the amount of feed resource supporting major herbivores in the park two things were identified first: firstly how much forage the particular animal or group of animals found in the park consume and secondly how much feed resources are available. Of the two methods of determining feed resource supporting animals in tropical countries, the Average Animal Weight (AAW) method was used, which is a more accurate method than the classic method. The average animal weight method uses one conversion factor (0.02667) [11]. This number was derived using the metabolic rate requirements of a cow with calf. Following calculation of total production of the area, total "Available" forages, feed requirement for the animals (Regardless of the breed or species) were determined. Furthermore, the daily and monthly forage requirement for the available animals considering their sizes by using the conversion factor of 2.667% was calculated. Finally, feed resource supporting major herbivores in the park were calculated by multiplying the number of animals with their feed requirements for one month [11].

Determination of Forage Nutrient Composition:

For determination of nutrient composition for grazing pasture species, samples were collected from identified plant species and chemical analysis was conducted. The samples were sorted with their categories, sun dried on open field and finally the dried samples were taken to Wollega University Biology laboratory where the samples were further dried at 60°C for 24 hours and stored carefully with clean paper folder and kept until they were taken to Debre-birhan Research center laboratory for chemical analysis.

Feed Samples Chemical Analysis: The feed sample reserved for chemical analysis was dried in an oven at 60°C for 24 hours and ground at 1mm sieve size in Wiley mil. The dry matter (DM) and ash was subjected to analysis following the procedure of AOAC [12]. The total Nitrogen (N) was determined by the Kjeldahl method AOAC [12] and crude protein (CP) content was calculated by $N \times 6.25$. The Neutral detergent fibers (NDF), acid

detergent fiber (ADF) and acid detergent lignin (ADL) were analyzed using the detergent extraction method Van Soest and Robertson [13].

Statistical Analyses: Data collected from measurements on botanical composition of the major forages used by buffaloes, biomass yields and chemical composition were analyzed using descriptive statistics of the Statistical Procedure for Social Sciences (SPSS) software, version 21, at $\alpha=0.05$.

RESULTS AND DISCUSSION

Biomass Yield of Native Pasture Most Preferred by Buffaloes in the Park: The biomass yield of major grasses grazed by buffaloes in Dharti Walal National park was indicated in Table 1. The grasses *C. papyrus*, *C. latifolius*, *H. filipendula*, *C. aterrimus* and *S. caespitosus* contributed 38%, 23%, 17%, 13% and 9%, respectively to the production of native forage in the park. This indicates that *C. papyrus* was the most dominant grass in the park followed by *C. latifolius*. The average DM production of all grass per quadrant (0.25 m²) was 75.56g. From the total area of the park about 900km² is covered by grassland. Therefore, grazing land could produce about 272.02 tons per 900km² of grass on dry mater basis per harvest. This is equivalent to about 3.02 tons/ha per harvest. From these results, it is clear that *C. papyrus* has contributed much to the grazing resources of the animals followed by *H. filipendula* and *C. aterrimus*. The last one, *C. aterrimus*, was the most nutritious plant in the park (Table 7).

Botanical Composition of Major Grazing Resources of Buffaloes in Park: The botanical composition of herbaceous plants consumed by buffaloes in Dharti Walal National Park was given in Table 2. From types of grass species found in the park *H. hirta* were the most dominant feed for buffaloes to graze (26.9%) followed by *H. filipendula* (19.23%) and *C. latifolius* (15.38%). These are three dominant native pasture species for buffaloes in the Dharti Walal National Park. They are not only dominant but the most preferred feed types by the buffaloes. Of these grass species; *H. hirta* is available only in rainy season. Which indicates it is seasonal feed resource of the buffaloes in the park. As opposed to the dominant and preferred grass species indicated above, *H. hirta*; *C. papyrus*, "Shiiffe" and *G. scabra* are the grass species less preferred by the buffaloes in the current study. These forages are consumed when the most preferred grasses are not available.

Table 1. Biomass yield of major grasses used by buffaloes in the park

Type of grass plant	PIGL	TDMY (tons)
<i>Cyperus papyrus</i>	38	10336.95
<i>Cyperus latifolius</i>	23	6256.575
<i>Hyparrhenia filipendula</i>	17	4624.425
<i>Cyperus aterrimus</i>	13	3536.325
<i>Sporobolus caespitosus</i>	9	2448.225
Total	100%	27202.5

PIGL = Percentage in the grassland, TDMY= total dry mater yield in the park

Table 2: Species composition of some herbaceous plants grazed by the Buffaloes

Grass species	Common name	Frequency	Percent (%)
<i>Hyparrhenia hirta</i>	Shaaloo	7	26.92
<i>Hyparrhenia filipendula</i>	Citaa	5	19.23
<i>Cyperus latifolius</i>	Baballii	4	15.38
<i>Cyperus aterrimus</i>	-	3	11.54
<i>Sporobolus caespitosus</i>	Ashuufee	2	7.69
<i>Cynodon dactylon</i>	Coqorsa	2	7.69
<i>Guizotia scabra</i>	Haadaa	1	3.85
<i>Cyperus papyrus</i>	Yabaloo	1	3.85
Shiiffë¥	Shiiffë	1	3.85
Total		26	100

¥Shiiffë: is local name of the herb in the park

Almost all grasses consumed by buffaloes in the park are medium in height. In contrary to this [14, 15] states Buffalo prefer to graze longer grasses. Accordingly, buffaloes in Dhati Walal National Park consume *C. papyrus*, longer type of grass and it also the area buffaloes used to reproduce. Their preference of this grass may be not only for nutritional values but also to hide themselves against predators and hunters. Such botanical composition variations results in nutritional variations between grass species [16] and subsequent preference to a particular or few grass species by herbivores like buffaloes [17, 18].

Feed options of buffaloes during dry times & when flood covers grazing land was shown in Figure 1. The grassland of the park is not suitable to buffaloes when two conditions happen. Firstly during flood logging due to heavy rainy season and secondly during feed shortage due to dry periods and sometimes when grassland burned by honey hunters and local hives makers that needs to get “Soyama” for local hives construction. During heavy rainy season, the entire bottom lands of the grazing land are usually covered by water so these conditions force the buffaloes to move to the upland forest areas. In such cases, the buffaloes are forced to move to feed on browse plants, dried and longer type of grass (*C. papyrus*), cultivated crop fields of the neighboring society adjacent to the park and the last is grazing on the repeatedly grazed math in the grasslands. However, about 44% of the respondents reported that buffaloes move to forest and fed on browse plant.

Most Preferred Grazing Resources in the Park: The results indicated that *C. papyrus*, *C. latifolius*, *H. filipendula*, *C. aterrimus* and *S. caespitosus* were the dominant species with percentages of 38%, 23%, 17%, 13% and 9%, respectively. Identification of the most frequently happening grass or herbs in the grassland helps to distinguish its nutritional contribution to the animals. In cases, where buffaloes have no option and stay several times in grazing fields, the most dominating plant may be the one most ignored to graze on. This is because the preferred grass type is continuously cut, overgrazed and the weedy plants dominating the area. In the current study, since buffaloes have option (Browses), the dominant plants in the grassland may not be necessarily the ignored ones, may be the most adapted ones to the ecology and habitats in the park. In this case,

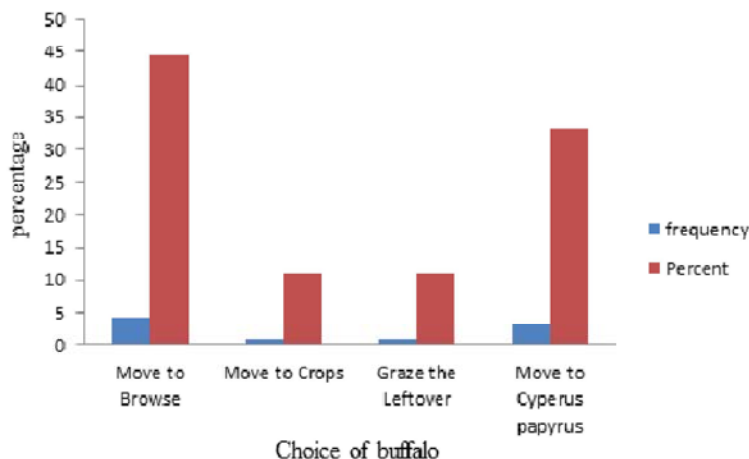


Fig. 1: Feed options of buffaloes during dry times & when flood covers grazing land

Table 3: Most preferred Herbaceous feed resources in Dhati Walal National Park

Grass species	Percentage (%)	Rank
<i>Cyperus papyrus</i>	38	1
<i>Cyperus latifolius</i>	23	2
<i>Hyparrhenia filipendula</i>	17	3
<i>Cyperus aterrimus</i>	13	4
<i>Sporobolus caespitosus</i>	9	5

Table 4: Estimated population for different classes of buffaloes in the park

Classes of Buffaloes	Numbers	Percentage (%)
Adult male	4133	34.4
Adult female	3134	26.1
Bull	1999	16.6
Heifer	1733	14.4
Calves	1001	8.3
Total	12,000	100

Table 5: The Estimated mean weight of buffaloes in DhatiWalal National Park

Classes of buffaloes	Weight of buffalo	Percentage (%)	Mean weight
Adult male	800-900	100	850
Adult female	700-800	55.6	750
Bull	600-750	77.8	675
Heifer	600-700	55.6	650
Calves < 3year	300-400	66.7	350
Total Weights			3275
Average wt. for one buffalo			655kg
For all 12000 animals			7,860,000kg

it may be important to trace the good nutritional potential of these dominating grasses and herbs in the park as indicated in Table 7. Such information or knowledge of species composition may also be relevant in grazing land management.

Stocking Rate of Buffaloes in the Park: The total population of buffaloes in the park estimated for each age category (adult male, adult female, bull, heifer and calves) of buffaloes were given in Table 4. Number of buffaloes in the Dhati Walal National Park is estimated to be around 12,000 [7]. According to respondents, the majority of buffaloes were male (51.10%) followed by females (40.5%) and the remaining population was estimated to be calves (8.33%).

This percentage indicate that from 12,000 buffaloes in the park, about 4133, 3134, 1999, 1733 and 1001 were adult males, adult females, young bulls, heifers and calves, respectively. This shows that young animals which are expected to be replacers of the old stocks were less in number than the old animals. This needs due care during legal hunting of the animals that the young ones should

be taken care of. Knowing or having appropriate estimation of the stock size in the park helps to estimate the stocking rate and thereby the forage availability and the balance of grazing ecosystem.

Estimated mean weight of buffaloes in the Dhati Walal National Park was presented in Table 5. The estimated weight of the adult male buffalo was about 800-900kg which was assumed as two times their larger bull. Body weight ranges from 700-800kg, 600-750kg, 600-700kg, 300-400kg for adult female, bull, heifer and calves respectively. In the aspect of their height, the adult male buffaloes are clearly identified from a long distance because of its height higher than all of the buffalo's class in its species. However, the height of bull and heifers are mostly close to adult female buffaloes. But their sex is determined by looking hump (Wither), udder and general body conformation. Males hump is clearly noticed. Both male and female calves are fast growing which indicates that the forage status of the park is supporting their growth beyond their maintenance requirement even though their requirement was not yet standardized.

Population size, estimated weight of animal and equivalent TLU of some herbivores in Dhati Walal National Park was presented in Table 6. Different formulae for estimating TLUs may be utilized in different parts of the world, depending on common livestock breeds. However a single formula for estimating TLUs in this way is unable to account for different animal breeds, which may differ significantly in size. If the feed eaten is reasonably the same for the species being evaluated, the ratio of metabolic weights provides the best means of comparison. The common standard used for one tropical livestock unit of one cattle with the body weight of 250kg [19]. Population size, average weight of animal and TLU of some herbivores estimated in the Dhati Walal National Park are indicated in Table 5.

From the data obtained and then calculated herbivores: *S. caffer*, *R. arundinum*, *P. africanus*, *P. larvatus*, *H. amphibus* and *T. scriptus* were adding to 92,288TLU in the park. In more detail, 31,440TLU, 979.2TLU, 44,240TLU, 86.4TLU, 15,532TLU, 10.88TLU for African buffalo, Common reedbuck, Warthog, Bush pig, Hippopotamus, Common bushbuck, respectively. Therefore Stocking rate = $92,288\text{TLU}/90000\text{ha} = 1.025$. This indicates that one herbivore animal with live weight equivalent to 250kg was able to live on one hectare of land. Therefore, the grazing land in the park seems sufficient for the animals to provide year round feed provided weed/and or thorny bushes are not dominating the grassland.

Table 6: Population size, estimated weight of animal and equivalent TLU of some herbivores in Dhati Walal National Park

Common name	Scientific name	Local name	Population	Average weight	Total TLU
African buffalo	<i>Syncerus caffer</i>	Gafarsa	12000	655kg	31,440
Common reedbuck	<i>Redunca arundinum</i>	Warabo	2040	120kg	979.2
Warthog	<i>Phacochoerus africanus</i>	Karkaro	553	80kg	44,240
Bush pig	<i>Potamochoerus larvatus</i>	Boye	240	90kg	86.4
Hippopotamus	<i>Hippopotamus amphibus</i>	Robi	3530	1100kg	15,532
Common bushbuck	<i>Traglaphus scriptus</i>	Bosonu	68	40kg	10.88
Total	92,288				

TLU= tropical livestock unit

Table 7: Nutrient content of forage plants most preferred by buffaloes in study area

Types of sample	Chemical composition (%)					
	DM	Ash	CP	NDF	ADF	ADL
<i>Sporobolus caespitosus</i>	95	12.6	8.88	69.5	56.8	14.5
<i>Cyperus latifolius</i>	96	6.25	5.69	68.8	56.3	14.4
<i>Cyperus aterrimus</i>	96	10.4	23.5	40.7	29.2	9.86
<i>Cyperus papyrus</i>	95	8.4	15.6	51.2	40	10
<i>Hyparrhenia filipendula</i>	95	14.7	7.91	68.7	56.8	14.5

To calculate stocking rate of buffaloes there must be data of other animal competing buffaloes for feed resource in the park. For this reason, animals which are depending on feed resources in the park were identified. These animals are *Redunca arundinum*, *Phacochoerus africanus*, *Potamochoerus larvatus*, *Hippopotamus amphibus* and *Traglaphus scriptus*. Totally available feed resources in dry mater basis in the park was estimated as 19149874.76kg (=19149.87tons). From the total available feed resources all of the listed animals share in respect to their requirement. Accordingly about 6288.72tons, 3106.7883tons, 195.8604 tons, 35.392tons, 17.28 tones, 2.176 tons of feeds were required by African buffalo, Hippopotamus, Common reedbuck, Warthog, Bush pig and Common bushbuck, respectively. The total sum of the feed requirement by all the animals listed was about 9646.22 tons. From the total available feed resources of the park (19149.87 tons) about 9503.67 tons may be considered as quantitatively excess. This result indicates that the quantitative forage resource in the park was in good condition and it can also serve additional population of animals in the future.

Chemical Composition of Major Native Forages Grazed by Buffaloes in the Park: Chemical composition of native pastures most preferred to graze by buffaloes in the study area was given in Table 7. These forage species include *S. caespitosus*, *C. latifolius*, *C. aterrimus*, *C. papyrus* and *H. filipendula*.

Dry matter content of the selected feeds was observed to be in a very narrow range 95% to 96%. This may be associated to reduced number of herbaceous

plants mostly grazed by buffaloes and/or due to dry season time sampling of the pasture during which most herbaceous plants dry off and disappear so that the chance of obtaining variable species was decreased. The potential of the native forage to provide crude protein (CP) was in the range from 5.69- 23.47%. The highest CP content was obtained from *C. aterrimus* plants while the least was *C. latifolius*. The minimum CP required for normal rumen physiology of buffaloes was 7% of the diet [15]. From the forages listed below (Table 7), most of them (80%) were containing CP values more than the minimum required amount in the diets (7%). Feeds/Forages containing CP values 20% and above can be used as protein supplements [20]. The herbaceous forage plant, *C. aterrimus* (23.5%) identified in Dhati Walal National park was the most potential CP source forage plant followed by *C. papyrus* (15.6%) for the buffaloes. The highest CP containing forage, *C. aterrimus*, was the fourth abundant plant among most preferred pasture composition while the *C. papyrus* with 15.6% CP was the first abundant ones in the park. This shows that it needs to characterize the ecological niches of these two useful sources of protein for buffaloes for further propagation interventions.

CONCLUSION

During the study, about nine major grazing resources out of which five most preferred herbaceous native pasture species were identified. The calculated biomass production of the park was 3.02 tons/ha. From the estimated stocking rate of buffaloes, the grazing resource of the park was quantitatively in good condition and it

can also accommodate additional population of buffaloes in the future. The crude protein content of the preferred forages in the park ranged between 5.69 to 24.91%. The herbaceous plant *C. aterrimus* contained highest crude protein (23.5%) and lowest fiber and lignin contents. Hence it was identified as the most potential plant species in the park in terms of nutrient content.

Recommendations: From the survey result, it indicates that the propagation of the most nutritious herbaceous species identified in the park should be encouraged. Further evaluation of forage resources on the aspects of their *in vitro* digestibility would be important. Awareness creation of local community and park scouts is essential for conservation of the habitats with its nutritious flora. Park boundary should be established and controlled by the government to avoid domestic animals interference.

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