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Original Research

Species Composition, Biomass Yield, and Nutritive Value of Native Pasture in Amarti and Nashe Wetlands, Western Oromia, Ethiopia

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Abstract

The study examined herbaceous species composition, biomass yield, and nutritional value of native pastures in western Ethiopia's Amarti and Nashe wetlands. Each wetland area was transect-quadrat-surveyed for vegetation cover. 27 herbaceous plant species from 22 genera in 15 families were found in the Amarti wetland and 19 from 14 genera in 9 families in the Nashe. The Cyperaceae, Apiaceae, Poaceae, and Polygonaceae families provided 48.1% of the species in the Amarti wetland, but only 47.4% in the Nashe. Shannon diversity was 1.14 in Amarti and 1.44 in Nashe. The average herbaceous plant biomass yield in Amarti was 5.40tons/ha, while in Nashe it was 2.94tons/ha. Chemical composition of herbaceous plants studied: 6.94-7.36% CP, 64.69-70.04% NDF, 38.24-40.79% ADF, 3.96-7.51% ADL, 51.28-55.52% IVDMD. In general, native pasture in assessed wetlands was overstocked, losing species richness, and almost in poor condition. Nutritive values (especially during the dry season), area enclosure, buffering with neighboring zones, soil conservation, and invasive plant species control are needed.

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INTRODUCTION

Wetlands have a vital role in maintaining biodiversity, controlling waste and pollution, and acting as organic water storage areas. Wetlands are described by the Ramsar Convention of 1997 as swamps, bogs, peatlands, or water places that are artificially or naturally occurring, permanent or temporary, and that contain fresh, brackish, or salt water that can be standing or flowing. This definition also includes marine waters where the depth at low stream is no more than six metres. Ramsar (2004) states that Ethiopia is home to a variety of wetlands with diverse genesis.

In general, herbaceous plants predominate in wetlands in Africa, which are distinguished by standing water during the rainy season and wet soils throughout the dry season (Howard-Williams and Gaudet, 1985). These days, agricultural activities, drainage, soil and water extraction for brick production, and a lack of public awareness of wetlands all have a detrimental effect on the wellbeing of wetland ecosystems (Moges et al., 2016). In a similar vein, a number of Ethiopian wetlands are severely threatened by factors like population growth, socioeconomic shifts, and legislative initiatives that increase the demand for arable land (Dixon & Wood, 2003).

Ethiopia's dramatic geological history, wide latitudinal spread, and vast altitudinal range have made it a centre of origin and diversification for a substantial number of plants, animals, and their wild relatives, according to Ethiopian Biodiversity Institute, (2014). Ethiopia is also a biodiversity hotspot. Due to this diversity, environments that support the growth and survival of different plant and animal species have emerged, adding to the nation's overall biodiversity (Yohannes et al., 2011). Amarti and Nashe wetlands are the most promising of the many wetlands in western Ethiopia. There are common grazing areas along these wetlands that serve as important grazing resources for grazing animals. These areas have a mixed population of herbaceous plant species.

Concrete knowledge of wetland herbaceous plant species composition, biomass-yield and nutritive value is essential to maintain livestock productivity and sustainable use of wetland grazing resources for future uses. However, due to the expansion of arable land, the shrinkage of upland grazinglands, the conversion of wetlands to croplands, and expanded pond water, the pasture land in the area was getting languish and potential plant species fall under being vanished. Therefore, this study was initiated to assess species composition, biomass yield and nutritive values of native pasture in the Amarti and Nashe wetland grazingland areas.

MATERIAL AND METHODS

Description of the study areas

The Amarti and Nashe wetland sites are depicted in figure 1. Amarti and Nashe wetlands are found in Horro districts and Abay Choman, respectively in Horro Guduru Wollega Zone of Oromia National Regional State.

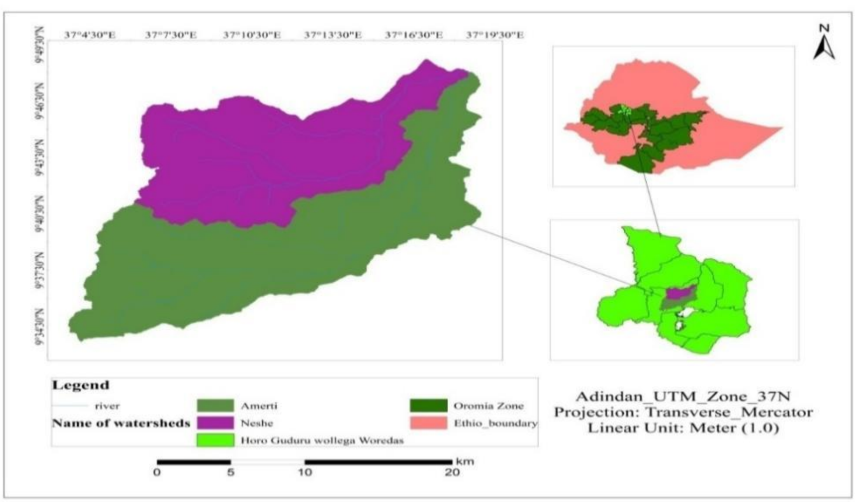

Figure 1: *Map of the study area in Horro and Abay Choman districts of Horro Guduru Wollega zone*

The study areas are found at approximately 289km west of Addis Ababa. Amarti wetland is located between 9˚34'30" to 9˚46'30"N latitude and 37˚4'30" to 37˚19'30"E longitude, whereas Nashe wetland is located between 9˚40'30" to 9˚49'30"N latitude and 37˚7'30" to 37˚19'30"E longitude. Grazing land area coverage of the study areas was estimated at 881.73ha for Amarti wetland and 55.32ha for Nashe wetland.

Method of Data Collection

The study areas were specifically selected due to the wetland herbaceous species composition and characteristics of reducing dry season feed shortage since its wetland vegetation of perennial standing wetlands of the area (Bezuayehu, 2006). A transect-quadrat method was applied to plant inventories in order to evaluate biomass output, percentage cover, and species composition (Shannon & Weiner, 1949). To this end, wetland boundaries have been drawn to the maximum level of flooding or the edge of the wetland to the upland community. For the present study, a 50mx5m (Gillison & Brewer, 2014) transects were created perpendicular to each wetland and 5 sampling quadrants of 1m^2 in size were systematically arranged within each transect at 10m intervals. Accordingly, at each wetland site, six transects measuring 50mx5m (3 on Amarti and 3 on Nashe) were created along the moisture gradient.

As a result, samples of 30 quadrats were taken from each of the two wetland locations' analysed transects. Every herbaceous plant sample that was available inside each quadrat was gathered based on the associated wetland location and transects. Based on the total grazing area of the wetland, a minimum distance between each transect was set at 450-500m to minimize the data dependency.

Vegetation sampling and identification

All herbaceous plants in the 1 m2 quadrats were divided into species that are classified as grasses, legumes, sedges, and forbs in order to assess the relative contributions of each group to the quadrat. Plant samples were gathered for in-depth identification. Next, individual herbaceous species were enumerated and recorded in each 1 m^2 quadrat to ascertain the relative plant abundance. An inventory of herbaceous vegetation within the 1m^2 quadrat, the number of plants per quadrat and vouchers was prepared for identification. For this purpose, voucher specimens with full heads and other vegetative parts were collected into a plastic bag, tagged for each quadrat reference number, after pressing overnight and packed tightly between newspapers. The National Herbarium of Addis Ababa University received all gathered and pressed specimens and used them to identify, assign, and label the many plant species (Tadesse, 2004; Kelbessa et al., 2014).

Above-ground biomass yield Determination

The biomass production of herbaceous species in the study areas was determined using destructive (harvesting) methods. The dry weight biomass (destructive biomass) assessment represents the weight excluding water content. Accordingly, 1m^2 quadrat was systematically placed at a 10m distances in the demarcated transect of the examined wetlands. In each 1m^2 sample in a quadrat, all herbaceous species were mowed together close to the ground with garden scissors, edible components were separated into sub-samples of grass, forb, legume, and sedge species in the field and the fresh weight of each available individual species was weighed into an A4 paper bag with a simple field scale in all sampling areas.

The samples were oven-dried for 48 hours at 65°C and then weighed until the sample reached a constant weight (Rau *et al*., 2009). The average biomass yield was determined (on a dry matter basis) per quadrant, converted to the total biomass yield per total grazable area in the wetlands (George, 2015). From these data (at the level of each sampled quadrat) the average biomass (ton/ha) was calculated for each herbaceous species of the examined quadrat over the entire quadrats. Forage dry matter yields were calculated using the formula) as stated below: Forage dry matter yield kg ha^{-1} = Fresh weight (kg) x Oven-dried weight (DM %) × 10,000. There is 10,000 quadrat ($1m^2$) per hectare.

Chemical Analysis

A basic field scale was used to record the fresh weights of the composite samples, which were subsequently oven-dried for 72 hours at 65°C in the Animal Nutrition Laboratory at Wollega University's Shambu Campus. After being partially dried, the samples were carefully placed in a fresh paper bag so that they could be nutritionally evaluated in the Holetta Agricultural Research Center's animal nutrition lab. The Wiley mill was used to grind the forage samples so they could be sieved through a 1 mm sieve for IVDMD analysis and nutritional composition analysis. By oven drying the samples for an entire night at 105°C, the DM percentage was ascertained. According to AOAC (2000), the samples were burned for six hours at 550°C in a muffle furnace to ascertain the total ash concentration. The Kjeldahl digestion, distillation, and titration method (AOAC, 2000) was used to estimate the nitrogen (N) content, and the nitrogen concentration was multiplied by 6.25 to determine the crude protein (CP) level. Van Soest et al.'s (1991) approach was used to determine the NDF, ADF, and ADL, or plant structural components. However, cellulose concentrations and hemicelluloses were calculated by deducting ADF from NDF and ADL from ADF, respectively.

Plant Sample In-vitro Dry matter Digestibility

The DM digestibility of prominent herbaceous plant species was assessed in vitro using the methodology developed by Tilley and Terry (1963), which was then modified by Van Soest and Robertson (1985), who substituted a neutral detergent solution for pepsin digestion in the second stage. The formula for tropical feed, which reads ME (MJ/kg DM) = DOMD (g/kg DM) x 0.16 (Mc Donald, 2002), was used to estimate the metabolizable energy (ME). The amount of digestible organic matter in the dry matter (DOMDM) was calculated using (AOAC, 2000).

Methods of Data Analysis

Vegetation data analysis

The species richness of herbaceous plants (sedges, forbs, legumes, and grasses) in each study area was determined as

$$S = \sum_{i=1}^{s} S\,i$$

Where: Si is the number of individuals in the i^{th} species.

Shannon's Wiener Diversity Index (H): - The Shannon index (H) is a measure of the number of species S and their even distribution according to the proportion (pi) of species (Shannon and Wiener, 1949) and is calculated as follows:

$$\text{Species diversity } (H') = -\sum_{i=1}^{S} (pi) * (\ln Pi)$$

Where: H' = Shannon-Wiener index, S = total number of species in the community, Pi = proportion or abundance of individuals of the i^{th} species, and ln = natural log of the number.

Species equitability or evenness index (J): - The species equitability or evenness index was used to calculate how evenly the species were distributed in the study area (Atsbeha *et al*., 2015). Species evenness was determined using Shannon species equitability (J) (Pielou, 1969). Evenness (J) ranges between 0 and 1, where 1 indicates an equal distribution and values approaching 0 mean unequal distribution (Pielou, 1969).

$$\text{Species evenness (j)} = \frac{H'}{H\max}$$

Where: J = Pielou evenness, H′ is Shannon-Wiener's diversity index for the quadrat, and H' max = lnS or natural log of species richness (S).

Dominance (D):- The dominance of herbaceous plant species in the study wetland areas was calculated as:

$$\text{Dominance(D)} = \frac{\text{Abundance of individual of individual species in a sample}}{\text{Total abundance of all species in a sample}} * 100$$

RESULTS AND DISCUSSION

Native Pasture in the Wetland of the study areas

Different species of native pastures identified in Amarti and Nashe wetlands are presented in Table 1. A total of 27 plant species belonging to the 22 genera in 15 families were identified at Amarti and 19 plant species belonging to 14 genera in 9 families were identified at Nashe wetland. Of the 27 identified plant species, the family *Cyperaceae* had 4 (14.8%), *Apiaceae*, *Poaceae* and *Polygonaceae* each possessed 3 (11.1% each) species, *Asteraceae*, *Onagraceae*, and *Thelypteridaceae* each possessed 2 (7.4% each) species, *Caryophyllaceae*, *Euphorbiaceae*, *Fabaceae*, *Lamiaceae*, *Geraniaceae*, *Lythraceae*, *Campanulaceae* and *Rubiaceae* each possessed 1 (3.7% each) species in the Amarti wetland and of 19 identified plant species, *Cyperaceae* possessed 5 (26.3%) species, *Poaceae* possessed 4 (21.1%), *Apiaceae*, *Onagraceae* and *Asteraceae* possessed 2 (10.5% each), *Lamiaceae*, *Caryophyllaceae*, *Polygonaceae*, and *Thelypteridaceae* possessed 1 (5.3% each) species in Nashe wetlands (Table 1).

The four species-rich families in the Amarti wetland *Cyperaceae*, *Apiaceae*, *Poaceae* and *Polygonaceae* contributed (48.1%) whereas *Onagraceae*, *Thelypteridaceae*, and *Asteraceae* contributed (22.2%) and the remaining 8 families contributed (29.6%) of the total plant species. In the Nashe wetland, the two species-rich families *Cyperaceae* and *Poaceae* contributed (47.4%) whereas *Apiaceae*, *Onagraceae*, and *Asteraceae* contributed (31.5%) while the remaining 4 families contributed (21.2%) of the total herbaceous plant species.

In the current study, the families *Cyperaceae, Apiaceae, Poaceae, Polygonaceae,* and *Asteraceae* in the Amarti and *Cyperaceae, Apiaceae, Poaceae,* and *Asteraceae* in the Nashe wetlands were the most dominant plant species. *Poaceae* and *Asteraceae* families were also the dominant wetland plants in other areas of Ethiopia (Belachew & Tessema, 2015). In terms of genus dominance, the genus Cyperus was most dominant in both Amarti and Nashe wetlands, contributing 4 species to total species of Amarti wetland and 5 species to total species of Nashe wetland, respectively. This genus is also reported dominant in East Africa and has 110 species in the flora of Ethiopia and Eritrea and 450 species in the flora of tropical East Africa (Lye, 2001).

Table. 1

Number of species per family observed in the Amarti and Nashe wetlands

	Amarti wetland			Nashe wetland			
No	Family	Species	(%)	No	Family	Species	(%)
1	Cyperaceae	4	14.8	1	Cyperaceae	5	26.3
2	Apiaceae	3	11.1	2	Poaceae	4	21.1
3	Polygonaceae	3	11.1	3	Apiaceae	2	10.5
4	Poaceae	3	11.1	4	Asteraceae	2	10.5
5	Asteraceae	2	7.4	5	Onagraceae	2	10.5
6	Onagraceae	2	7.4	6	Lamiaceae	1	5.3
7	Thelypteridaceae	2	7.4	7	Thelypteridaceae	1	5.3
8	Caryophyllaceae	1	3.7	8	Caryophyllaceae	1	5.3
9	Euphorbiaceae	1	3.7	9	Polygonaceae	1	5.3
10	Fabaceae	1	3.7		Total	19	100
11	Lamiaceae	1	3.7				
12	Geraniaceae	1	3.7				
13	Lythraceae	1	3.7				
14	Campanulaceae	1	3.7				
15	Rubiaceae	1	3.7				
	Total	27	100				

Of the total herbaceous species observed in the Amarti (27) and Nashe (19) wetlands, based on their life forms, about (19) in the Amarti and (9) in the Nashe wetlands were forbs species. This is in line with the report by Jawuoro *et al*. (2017); in which of the total (51) observed herbaceous species about 29 were forbs species in the piospheres of the southern Rangelands of Kenya which is a boarder country in the southern direction. Grazing pressure changes the species composition within pasture ecosystems (Wu *et al*., 2009). High grazing pressure reduces the density of palatable plants and forces the animals to look for species with low nutritional value (Amiri *et al*., 2008). Hence, the most preferred plant species stop growing and make way for forbs to propagate (Loydi *et al*., 2012). Similar observations have been made by Hoshino *et al*. (2009), who reported that changes in species composition along grazing gradients are characterized by changes in density and coverage of life forms, and annual and forb species are replacing perennial grasses near the piospheres (Table. 2).

Table. 2

Mean proportion of decreasers, increasers, and invaders in the study areas

Amarti wetland species categories								
	Decreasers		Increaser		Invader		Total	
Habit	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Forbs	0	0	5	18.5	12	44.44	17	63.0
Sedges	0	0	4	14.8	0	0	4	14.8
Grasses	1	3.7	2	7.4	0	0	3	11.1
Ferns	0	0	0	0	2	7.4	2	7.4
Legume	1	3.7	0	0	0	0	1	3.7
Total	2	7.4	11	40.7	14	51.9	27	100
	Nashe wetland species categories							
Forbs	0	0	3	15.9	6	31.8	9	47.7
Sedges	0	0	5	26.5	0	0	5	26.5
Grasses	1	5.3	3	15.9	0	0	4	21.2
Ferns	0	0	0	0	1	5.3	1	5.3
Total	1	5.3	11	58.3	7	37.1	19	100

Species richness, diversity, evenness, and dominance

The diversity of herbaceous plant species observed in the Amarti and Nashe wetlands is presented in Table 3. However, no significant difference (*p>0.05*) was recorded between the mean species richness of Amarti wetland and Nashe wetland. The wetlands examined were comparable in terms of species richness and composition that might be they were located in the same catchment area. Both study wetlands were permanently flooded wetlands of considerable depth in the center and with some emerging wetland grass species towards the uplands and the drained parts of them. These might be the main reasons for the similarity in species richness between these two wetlands. Deep floods and long-period standing water levels can reduce vegetation diversity according to Dwire *et al*. (2006). In contrast, Padgett and Crow (1995) reported that the shallow natural wetland is home to more plant species than the other natural wetlands due to its mosaic-like habitat. The mean Shannon species diversity index (H') in the present study was 1.14 in the Amarti wetland and 1.44 in the Nashe wetland. The diversity index value of the present study is below the range (1.5-3.5) reported by Gencer and Nilgun (2010). The result of the current study showed that there was no significant difference (*p>0.05*) between the mean Shannon diversity of the Amarti wetland (H' = 1.14) and (H' = 1.44) of the Nashe wetland (Table 3). A similar observation was made by M.V. Vincy *et al*. (2014) where there were no significant differences between the riparian species diversity index of the main river channel and sub-water shade of the Meenachil river basin in southern India.

Table. 3

Species diversity of herbaceous plants measured in the study areas

Wetland	Species richness(S)	Shannon Diversity(H')	Evenness(E)	Dominance(D)
Amarti	12.00	1.14	0.46	0.50
Nashe	10.67	1.44	0.61	0.37
Mean	11.33	1.29	0.54	0.44
p-value	0.5886	0.3274	0.1908	0.2905
LSD	6.25	0.51	0.24	0.20
CV	15.70	11.20	12.56	13.31

LSD = Least significant difference; CV= Coefficient of variation

Biomass yield of herbaceous plants in the Amarti and Nashe wetlands

The total biomass (DM) yields of native pasture in both study wetlands are given in Table 4. The herbs *C. difformis, L. hexandra, C. plectostachyus, C. latifolius,* and *S. caespitosus* contributed 58.02(71.69%), 13.29(16.42%), 2.66(3.29%), 1.53(1.89%) and 0.99 tons/ha (1.22%), respectively. *C. difformis, L. hexandra, S. corymbosus, C. latifolius, D. integrifolia* contributed 20.12(45.73%), 9.49(21.56%), 5.56(12.63%), 4.82(10.95%), 0.82tons/ha (1.86%), respectively in Nashe wetland. This indicates that *C. difformis* was the dominant herbaceous species followed by *L. hexandra* in terms of total biomass (DM) yields in both study wetlands. The other rare species contributed 4.45tons/ha (5.49%) in Amarti and 3.2tons/ha (7.28%) Nashe wetlands. Of the total area of the Amarti wetland, about 881.73ha was covered by grassland. Therefore, Amarti wetland could produce about 4,761.342tons per 881.73ha of grazing wetland on dry matter basis. This corresponds to about 5.40tons/ha per harvest. From these results it could be concluded that *Cyperus difformis* was a major contributor to the animals' grazing resources in the Amarti wetland, followed by *Leersia hexandra* and *Cynodon plectostachyus*. Of the total area of the Nashe wetlands, about 55.32ha are covered by grassland. Therefore, Nashe wetland could produce about 162.641tons per 55.32ha of grazing wetland on dry matter basis. This corresponds to about 2.94tons/ha per harvest. From these results it is clear that *Cyperus difformis* was a major contributor to the animals' grazing resources in the Nashe wetlands, followed by *Leersia hexandra* and *Schoenoplectus corymbosus*.

Table. 4

Biomass yield (ton/ha) of herbaceous plants species in the study areas

Amarti wetland			Nashe wetland		
Herbaceous species	TDMY	%	Herbaceous species	TDMY	%
Cyperus difformis	58.02	71.69	Cyperus difformis	20.12	45.73
Leersia hexandra	13.29	16.42	Leersia hexandra	9.49	21.56
C. plectostachyus	2.66	3.29	S. corymbosus	5.56	12.63
Cyperus latifolius	1.53	1.89	Cyperus latifolius	4.82	10.95
S. caespitosus	0.99	1.22	D. integrifolia	0.82	1.86
Other rare species	4.45	5.49	Other rare species	3.20	7.28
Total	80.93	100	Total	44	100

TDMY=Total dry matter yield

The mean ton/ha DM production of various herbaceous species in the study areas is presented in Table 5. The average herbaceous DM production of all grass per quadrat (1m^2) in the Amarti and Nashe wetland was 5.4 and 2.94 tons/ha, respectively. Of these grasses, sedges and forbs yield 1.13, 4.02, and 0.25 tons/ha respectively, in the Amarti wetland and 0.72, 2.05 and 0.17 tons/ha respectively, in the Nashe wetland. Total herbaceous DM production in the Amarti wetland was significantly ($p<0.05$) higher than the total herbaceous DM production in the Nashe wetland. This might be attributed to otherfactors such as the variation in land size and species dominance of the study areas. In general biomass yield was much lower in the Nashe wetland compared to Amarti wetland which might be because the stocking rate was much higher at Nashe wetland as opposed to the Amarti wetland. The livestock trampling and grazing pressure might result in grass undergrowth and DM yield at Nashe wetland. The current study is supported by the report by Ross *et al*. (2023) who documented biomass yields of wetland cattails were decreasing due to livestock trampling and grass undergrowth of wetland pastures. This is also in line with reports by Getachew (2005) who documented the low dry matter biomass contribution of highly desirable grass species under heavily grazed areas of Ethiopia. The average total DM biomass fraction of grasses, sedges, and forbs was 20.93%, 74.44% and 4.63% in the Amarti wetland and 24.49, 69.73, and 5.78% in the Nashe wetland. This study confirmed the argument by Zinash *et al*., (1995) and Solomon (2004) who documented that grass biomass is influenced by the intensity of grazing and the stage of defoliation, as well as different landscapes and land-use systems such as hills, rivers basins and riverbanks, fallow land, and swampy areas.

Table. 5

Mean ton/ha dry matter production of herbaceous plant species in the study areas

	Wetland plant categories				
Wetland	Grasses	Sedges	Forbs	Total biomass	N
Amarti	1.13	4.02	0.25	5.40	15
Nashe	0.72	2.05	0.17	2.94	15
Mean	0.92	3.03	0.21	4.16	
P-value	0.02781	0.006067	0.3106	0.001358	
LSD	0.36	1.35	0.15	1.37	
CV	53.12	59.03	97.96	43.51	

LSD = Least significant difference; CV= Coefficient of variation; N = number of sampled quadrats

Nutritive values of dominant native pasture species in the study areas

The chemical composition and *Invitro* DM digestibility of various herbaceous species in the studied wetland is shown in Table 6. The forage species include Leersia hexandra, Schoenoplectus corymbosus, Cyperus latifolius, and Cyperus difformis. The present study showed that the dry matter content of the selected forage species was in a very narrow range of 92.07-93.34%. While the highest (93.34%) value was recorded in *S. corymbosu*s, the least (92.07%) value was recorded in *C. difformis*. The dry matter content of the plants varies depending on various factors such as plant species, plant parts, growth conditions, soil, and environment (Sekeroglu *et al*., 2006).In the present study, the ash content was between (4.52-7.70%) and the highest (7.70%) ash content obtained was measured in *L. hexandra*, while the lowest (4.52%) was measured in *S. corymbosus*. The ash contents of the current study were higher than that of the swamp vegetation in South Kalimantan of (2.18-3.28%) during the high tide season and in the range of (3.23-9.83%) during the low tide season (Rostini *et al*., 2014) and lower than (5.63-25.19%) in the lowland swamp vegetation, reported by Muhakka *et al*., (2020).

The native wetland forage crude protein (CP) contents of the present study ranged from 6.78-7.36%. Among the herbaceous species examined, the crude protein content was highest in *L. hexandra* (7.36%) and lowest in *S. corymbosus* (6.94%). Statistically, there was no significant (*$p>0.05$*) difference between the studied wetland herbaceous plant species, though a numerical difference was found between the selected wetland herbaceous plant species. The crude protein content of the wetland plants observed in the present study was in the range (3.0-10%) of other grasses reported by El-Amier and Abdullah, (2015); Bouba et al. (2012) and Imam *et al*. (2013). *L. hexandra* with the highest (7.36%) CP was the second most frequent after *C. difformis* with CP, which had the highest (6.78%) frequency in both wetland areas under investigation.

The neutral detergent fibre determined in the current study (64.69-70.04%) nearly exceeds the range of cell wall per leaf dry mass (18-70%) assessed over numerous plant species (Onoda et al., 2017) and was within the range reported by Muhakka et al. (2020).

However, instead of concentrating only on leaves, the current study evaluated all edible plant tissue, and the NDF levels reported here include cellulose, hemicelluloses, and other structural or defense components. Therefore, the inclusion of fibrous structural components like flowers, stems, and other chemicals that raise the NDF values can account for this wider range of NDF values. The marsh plants in this investigation had acid detergent fibre in the range of (38.24–40.79%), with *S. corymbosus* having the highest value and *C. difformis* having the lowest. According to Muhakka et al. (2020), the present ADF values fell between 23.66 to 60.33 percent in the lowland swamp vegetation.

The cellulose value of the present study ranged between (30.74-36.07%) with the highest cellulose content found in *S. corymbosus* and the lowest in *C. difformis* however, higher than the report by Muhakka *et al*., (2020), in which the cellulose values of the lowland swamp vegetation ranges between (5.24-27.08%). The hemicelluloses value of the present study ranged between (25.24-31.10%), with the highest value recorded in *C. difformis* and the lowest value in *L. hexandra*. The hemicelluloses values (25.24-31.10%) of the current study was in the range of the hemicelluloses values (7.73-37.14%) of the lowland swamp vegetation, which was reported by Muhakka *et al*. (2020). The hemicelluloses values (25.24%) of the wetland grass *L. hexandra* in the current study is lower than the hemicelluloses values (37.14%) of the same wetland grass species reported by Muhakka *et al*. (2020).

Table. 6

Chemical composition and invitro dry matter digestibility of native pasture species in the Amarti and Nashe wetlands

		Chemical composition and invitro dry matter digestibility (% DM)									
Plant species	DM	Ash	CP	NDF	ADF	ADL	CL	HCL	IVDMD	DOMDM	ME
S. corymbosus	93.34[a]	4.52[c]	6.94[a]	70.04[a]	40.79[a]	4.73[c]	36.07[a]	29.25[a]	55.52[a]	46.49[a]	7.44[a]
C. latifolius	92.92[a]	5.67[b]	6.93[a]	69.65[a]	40.04[ab]	5.56[b]	34.48[a]	29.61[a]	52.81[b]	43.61[b]	6.98[b]
L. hexandra	92.88[a]	7.70[a]	7.36[a]	64.69[b]	39.45[ab]	3.96[d]	35.49[a]	25.24[b]	52.38[bc]	43.15[bc]	6.90[bc]
C. difformis	92.07[b]	5.47[bc]	6.78[a]	69.35[a]	38.24[b]	7.51[a]	30.74[b]	31.10[a]	51.28[c]	41.98[c]	6.72[c]
Mean	92.80	5.84	7.00	68.43	39.63	5.44	34.19	28.8	53.00	43.81	7.01
P-value	0.003	0.000	0.558	0.011	0.034	$3.18e^{-07}$	0.002	0.006	0.000	0.000	0.000
LSD	0.53	1.01	0.93	3.09	2.36	0.49	2.29	2.81	1.17	1.24	0.20
CV	0.35	10.78	8.29	2.82	3.72	5.62	4.19	6.11	1.38	1.77	1.77
R^2	0.79	0.86	0.56	0.74	0.72	0.97	0.86	0.74	0.94	0.94	0.94

Means with different superscript letters in a column are significantly different (P<0.05). LSD=Least significant difference; CV = Coefficient of variation; R^2 = R-squared; DM = Dry matter; CP = crude protein; NDF = neutral detergent fiber; ADF = acid detergent fiber; ADL= acid detergent lignin; CL = Cellulose; HCL = Hemicelluloses; IVDMD = in vitro DM digestibility; DOMDM = Digestible organic matter in the dry matter, ME = metabolizable energy.

The lignin values of the current finding were low, ranging between (3.96-7.51%), with the highest in *C. difformis* and the lowest in *S. corymbosus* and lower than the lignin values (14.84-43.09%) of lowland swamp vegetation, reported by Muhakka *et al*., (2020). The lignin content in this study is within the range reported by Rostini *et al*. (2014) who reported that the lignin content of swamp vegetation in South Kalimantan was between (2.8-17.59%) during the midsummer season. The lignin levels of *L. hexandra* (3.96%) found in this study were lower than the lignin levels of the same plant (17.96%) that were reported by Tham (2015) and (33.92%) by Muhakka *et al*. (2020). The IVDMD of the present study ranged between 51.28-55.52% with the highest (55.52%) measured for *S. corymbosus* and the lowest (51.28%) for *C. difformis*. The digestible organic matter in the dry matter (DOMDM) of the present study ranged between (41.98-46.49%) with the highest in *S. corymbosus* and the lowest in *C. difformis*. The ME value of the current study ranged between (6.72-7.44%), the highest in *S. corymbosus* and the lowest in *C. difformis*. Because these aquatic plants have a low energy content, it is necessary to supplement them with energy sources (Babayemi, 2006) to provide the animals with the energy they require for regular maintenance and production. This is supported by the low level of ME in this study.

CONCLUSIONS

From the current study, it could be concluded that herbaceous plants in the study wetlands had moderate amounts of crude protein and low level of Metabolozable energy. The pasture resources in these study areas were fed to livestock, especially during the dry season, when upland forages were generally scarce. There were large reserves of wetland herbaceous plant species in the study areas and that they could potentially be used for livestock feeding, especially during the dry season when the upland forage dries up. These feeds, if fully managed and used, could help to increase the production and productivity of livestock in the area. The species composition, biomass yield and nutritive value of the wetlands studied suggested that the wetland natural pasture of the areas were being deteriorating, and are demanding for management improvement and natural resources conservation practices. The effect of climate change, poor wetland pasture management and lack of clear policy towards wetland management and utilization needs further research.

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DECLARATION

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

DATA AVAILABILITY

Data will be made available on request

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