Variations in chemical nutrients and mineral concentrations of water hyacinth (*Eichhornia crassipes* Mart. Solms-Labauch)

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Abstract

Laboratory studies were conducted to evaluate changes in chemical nutrients and mineral concentrations of water hyacinth as influenced by the season of harvest, habitat and morphological parts of the plants. Proximate composition (DM, CP, CF, EE and ash), fiber fractions (NDF, ADF and ADL) and concentrations of minerals (Ca, P, K Na, Mg, Fe, Zn, Mn, and Pb) in water hyacinth harvested from canal, lagoon, river and dam at the early and late period of wet and dry seasons were determined. Results showed that CP, EE and ash contents of water hyacinth harvested from the different water bodies differ ($P < 0.05$). Dry matter and CP values ranged from 7.68 to 7.96 and 10.32 to 10.40 g/100g DM in water hyacinth from river and dam respectively. Effects of the season on the chemical nutrient composition of water hyacinth were not significant ($P > 0.05$) except for DM that was highest (8.22) in the late dry season. Water hyacinth harvested from the different water bodies contains relatively high levels of minerals that vary ($P < 0.05$) with the season of harvest. The high CP and mineral concentrations of water hyacinth suggests that the plant can be used as fodder for ruminant livestock production.

Key words: water hyacinth; proximate composition; mineral concentration

Introduction

In many of the ruminant production systems in the developing world, natural grass pastures make the bulk of feed. This is because ruminants are endowed with the ability to degrade and utilize forages with the help of rumen microbes. Babayemi, (2007), reported that the quality and seasonal nature of forage supply together with low intake and poor digestibility of forages by animals are major factors that contribute to low productivity by ruminant animals. Dietary protein intake, particularly that of animal origin is low in the tropics, the conventional feedstuffs like cereals for farm animals are becoming impossible for large scale farmers due to soaring prices of such feeds. A lot of work had been done on the protein and energy requirements of various classes of animals

and also their ability to utilize the protein and energy present in such feeds effectively. Little importance has been given to mineral requirements of indigenous livestock especially ruminants in Nigeria. The deficiency and imbalance of minerals affects the utilization of protein and energy. The supply of minerals for animal use is from dietary source, since animals cannot synthesize mineral elements from the body. Grasses in Nigeria are deficient in phosphorus while most forages are deficient in other minerals varying from one geographical location to the other (Lizama et al., 1989). Hence, the need to identify and introduce lesser known feedstuffs capable of growing without cultivation, with less agronomic care and which is of no use to man. Water hyacinth is an important class of such feedstuffs.

During the dry season when most grasses, legumes and browse plants dry up and shed their leaves, water hyacinth are available and thus remain the available green vegetation (Mako and Babayemi, 2008).

Materials and methods

Collection of samples and Chemical Analysis

Water hyacinth (*Eichhornia crassipes*) used for this study was collected in the months of May-, August-, November- 2005 and February 2006 to coincide with the early rain, late rain, early dry and late dry seasons from canal, lagoon, river and dam. Twenty five (25) stands were harvested randomly from the different water bodies. Harvesting was done manually. The harvested samples were washed thoroughly, separated into morphological parts and taken to the laboratory for moisture, chemical nutrients and minerals determination.

Representatives of the plant sub samples were oven dried at 105 °C until constant weight after which it is cooled in a dessicator. The dried samples were milled in a Thomas Willey laboratory mill fitted with 0.5 mm mesh. The milled samples were kept in air tight bottles until they were needed for chemical analysis.

Proximate components, including crude protein, crude fibre, ether extract and total ash of the dried samples were analyzed in triplicates using standard procedures of A.O.A.C (1995). The crude protein was determined with the micro Kjeldahl distillation apparatus, while the neutral detergent fibre (NDF) and acid detergent fibre (ADF) contents of the plant samples determined as described by Van Soest *et al.* (1994)

A total of ten minerals were analysed. WH collected from the different water habitats during each period of the season were

digested with HNO₃ / HClO₄ mixtures (nitric acid and perchloric acid) (20:5 v/v). The digest was made up to 100 ml in standard volumetric flask with deionized water. Ca, Na, K, Mg, Fe, Cu, Zn, Mn and Pb in the digest were determined with the atomic absorption spectrophotometer model 420. (Gallenkemp and Co. Ltd). Phosphorus in the digest was estimated with vanadomolybdate solution. The colour so developed was read with spectrophotometer at 420 m/u.

Statistical Analysis

Parameters were analyzed in a completely randomized design. Data collected were subjected to analysis of variance procedure (ANOVA) of SAS (1999). Significant means were separated using the Duncan multiple range test of the same package.

Results and Discussion

Table 1 presents the proximate composition of water hyacinth (WH) harvested from the different aquatic habitats. It was observed that the dry matter (DM) was low in all the samples analyzed. Dry matter values ranged from 7.68 (river) to 7.97 (lagoon). The DM obtained for WH in this study is consistent with the report of Dairo (1997) and Babayemi *et al.*, (2006). This low DM is a limiting factor in feeding the plant on fresh basis to animals since animals will have to take a large quantity to meet requirements. This can be ameliorated by dehydrating the plant under the sun as wilted, hay (Mako and Babayemi, 2008) or as silage (Akinwande *et al.*, 2011). The effect of different aquatic habitats on the DM was not significant implying that WH harvested from any of these water bodies can be used.

The Crude protein (g/ 100 g DM) obtained for WH from different water bodies differed significantly ($p < 0.05$). The values ranged from 10.32 (river) to 10.40 (dam). The

Table 1: Proximate composition (g/ 100 g DM) of water hyacinth as affected by different water sources

Parameters	Canal	lagoon	River	Dam	SEM
Dry mater	7.70	7.97	7.68	7.96	0.05
Crude protein	10.36b	10.36b	10.32c	10.40a	0.003
Crude fibre	19.22	19.34	19.33	19.25	0.05
Ether extract	1.56a	1.55b	1.54b	1.55b	0.02
Ash	22.19a	19.37b	19.54b	19.40b	0.002

a, b = means on the same row with different superscripts are significant ($p < 0.05$)

reason for this variation could be attributed to the continuous water flow in the river, thereby washing nutrients off, while water in the dam by its characteristics is stagnant. The CP of WH from all water the different habitats is relatively higher than the CP of some grasses and browse plants. The CP of Guinea grass is between 7 - 8 % (Ajayi *et al.*, 2005). The average CP in the present study (10.36) is higher than the recommended level of 6–7 g/ 100 g DM for ruminant below which feed intake is depressed (Minson, 1990). The plant is high in Ash, that ranged from 19.37 (river) to 22.19 (canal), this suggests that water hyacinth can serve as a good mineral source to the livestock.

Table 2, show chemical composition of WH harvested during the early rain (ER), late rain (LR), early dry (ED) and late dry (LD) seasons respectively. The highest DM (8.22g / 100g DM) was recorded during the LD season, while the least DM (7.63g / 100g DM) was obtained during the ER and LR seasons. The least (10.28 %) and highest (10.42 %) CP was obtained in ER and LD respectively. The CF ranged from 19.16 to 19.47 g/100g DM in ER to LD respectively. The ash content ranged from 19.94 to 20.54 % in ER to LD respectively. The NDF, ADF and ADL ranged from 55.62 to 56.29, 35.19 to 35.60 and 10.51 to 10.75 in ER and LD respectively

The increase in DM value from ER to LD season may be attributed to increase in age of the forage as season progresses (Babayemi *et al.*, 2006). On fresh basis, the average DM in WH compared well with the values of 5 – 9% reported for some water weeds (Khan *et al.*, 2002), but lower than values of 20 and 21 percent reported (NRC, 2001) for oats (*Avena sativa*) alfafa (*Medicago sativa*), also lower than values of 24.63 % and 23.27 % reported (Babayemi; 2006) for duck weed (*Spirodela polyrrhiza*) and water fern (*Nephrolepis biserrata schott*). Possibly due to the aquatic plant ecological habitat, season did not show deteriorating effects on its nutrient composition, indicating therefore, it's potential to sustain ruminant all year round (Babayemi *et al.*, 2006). The level of CP obtained in this study is comparable to some common leguminous fodder plants (Ngwa *et al.*, 2003). Water hyacinth may be considered as a valuable supplement for animals feeding on low quality crop residue. The CP content of WH was above the minimum level for maintenance of 7.7 % for goats (NRC, 2001). The CF obtained for WH in this study is low compared to some forage *Panicum maximum* (74.1), *Gliricidia sepium* (66.31) and *Leucaena leucocephala* (67.50) (Babayemi 2007). This corroborates the findings of Bailey (1965)

who reported that aquatic plants are less in CF than many tropical types of forage on dry matter basis. The value of ash is high and could be attributed to the ability of WH to absorb minerals extensively from water (Holms *et al.*, 1997). Ash content reflects the mineral composition of WH, and suggests ability of WH to supply mineral to animals. The fibre fractions fall within the range reported elsewhere for water hyacinth (Aboud *et al.*, 2005). The level also compared well with values obtained for some browse plants elsewhere (Ademosun *et al.*, 1988). The NDF concentrations are higher than the reported values of 49.9 - 54.2 % (Sopha *et al.*, 2010) and within the range value of 55.0 - 60.0 g/100g DM above which intake of forages can be depressed (Meissner *et al.*, 1991). The concentrations of macro and micro minerals in water hyacinth (Table 3) were not affected by the different habitats. Concentrations of Ca ranged from 0.64 to

0.66 g/100 DM while Fe ranged from 516 to 527 Ppm. The macro - and micro - mineral contents of WH from the habitats are within the values recommended for grazing animals (NRC 2001). This is an indication that WH has the potentials to supply adequate minerals to ruminants. The macro and micro mineral content of WH are higher than the conventional forages which is in agreement with other results. The results obtained in this study for Fe, Mn and Zn was comparable to the findings of Grandi, 1981 and Lizama *et al.*, 1989.

Macro and micro mineral concentration of water hyacinth harvested during the four periods of the year are shown in Table 4. It was observed that Ca, P, K, Fe, and Zn differed as the season progressed, while Na, Mg, Cu, Mn and Pb were not affected by season. However, Ca ranged from 0.60 to 0.69 g/100 DM, levels of Fe ranged from 502.1 to 541.8 Ppm.

The values of macro and micro minerals

Table 2: Chemical composition (g /100 g DM) of water hyacinth as affected by seasons

Parameters	Season				SEM
	ER	LR	ED	LD	
Dry matter	7.63 ^b	7.63 ^b	7.93 ^b	8.22 ^a	0.05
Crude protein	10.28	10.38	10.38	10.42	0.20
Crude fibre	19.16	19.25	19.32	19.47	0.10
Ether extract	1.54	1.55	1.55	1.56	0.02
Ash	19.94	20.31	20.53	20.54	0.10
Nitrogen detergent fibre	55.62	55.88	56.02	56.29	0.30
Acid detergent lignin	10.51	10.61	10.71	10.75	0.14
Acid detergent fibre	35.19	35.32	35.45	35.60	0.20

a b = means on the same row with the same superscripts are significant ($p < 0.05$), ER= early rain, LR= late rain, ED=early dry, LD= late dry, SEM = standard error of mean

Table 3: Macro and Micro mineral content of water hyacinth as affected by different aquatic habitats

DWS	g/100 g DM					Ppm				
	Ca	P	K	Na	Mg	Fe	Zn	Cu	Mn	Pb
1	0.64	0.18	0.39	0.16	0.16	516	51.9	12.3	682	19.0
2	0.66	0.20	0.42	0.17	0.17	523	50.8	12.3	678	16.2
3	0.65	0.20	0.42	0.15	0.15	527	52.6	12.2	680	17.2
4	0.65	0.24	0.38	0.17	0.17	524	52.9	11.3	676	15.0
SEM	0.29	0.03	0.02	0.02	0.02	10.9	1.11	0.32	9.30	0.20

DWS 1 – canal, 2 – lagoon, 3 – river, 4 – dam

obtained here are lower than the values reported elsewhere (Khan et al., 2002). However the values are within the ranged recommended for grazing animals (NRC, 2001). This is an indication that water hyacinth can provide adequate minerals for livestock.

Macro and micro mineral concentrations of water hyacinth were not affected by the morphological parts (Table 5). However, Ca ranged from 0.60 to 0.81 g/100 DM and Fe ranged from 521.70 to 712.00 ppm. The values of macro and micro minerals obtained in this study are lower than the values reported elsewhere (Khan et al.,

2002). However the values are within the ranged recommended for grazing animals (NRC, 2001).

Conclusion

The proximate composition of water hyacinth harvested from different water sources during the four periods of the year showed that the plant is rich in nutrients especially CP. Also, the plant contained adequate mineral content that is within the recommended value as maintenance and production ration. This implies that the plant can be utilized as feed for animals, especially ruminants in the tropics.

Table 4: Macro and micro mineral content of water hyacinth as affected by seasons of the year

Season	g/100 g DM					Ppm				
	Ca	P	K	Na	Mg	Fe	Zn	Cu	Mn	Pb
ER	0.63 ^b	0.16 ^b	0.37 ^b	0.18	0.16	505.6 ^b	52.19 ^b	11.91	578.0	18.0
LR	0.60 ^b	0.12 ^b	0.34 ^b	0.19	0.17	502.1 ^b	50.70 ^b	11.85	567.4	17.2
ED	0.67 ^a	0.22 ^a	0.42 ^a	0.20	0.19	540.5 ^a	53.35 ^a	12.00	589.2	18.2
LD	0.69 ^a	0.25 ^a	0.43 ^a	0.20	0.27	541.8 ^a	53.89 ^a	12.54	596.5	20.0
SEM	0.02	0.03	0.02	0.03	0.02	2.81	0.61	0.26	9.30	0.30

a b = means on the same row with the same superscripts are significant ($p < 0.05$), Season = ER= early rain, LR= late rain, ED=early dry, LD= late dry, SEM = standard error of mean

Table 5: Macro and micro mineral content of water hyacinth as affected by morphological parts.

MP	g/100 g DM					Ppm				
	Ca	P	K	Na	Mg	Fe	Zn	Cu	Mn	Pb
Leaf	0.60	0.14	0.34	0.22	0.16	523.69	51.86	12.19	678.0	19.0
Stem	0.62	0.16	0.35	0.25	0.17	521.70	52.19	11.85	682.4	17.2
Leaf+ stem	0.67	0.22	0.42	0.26	0.19	527.00	52.98	13.00	689.2	18.2
Root	0.81	0.43	0.60	0.43	0.27	712.00	68.23	15.54	776.5	25.0
SEM	0.02	0.03	0.02	0.03	0.02	10.93	1.11	0.35	9.30	0.30

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