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Nutritive Characteristics of Two Tropical Aquatic Weeds for Ruminants

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Abstract

The nutritive values of water hyacinth (*Eichhornia crassipes*) and water lettuce (*Pistia stratiotes*) for ruminants were evaluated using chemical and mineral analyses, ensiling, in vitro and in situ digestion studies. The aquatic weeds contained lower levels of dry matter (DM), but higher levels of CF and ash than GG. WL contained higher levels of organic matter (OM), CP and crude fibber (CF) that WH. CP was concentrated in the leaves of the aquatic weds. The roots contained the highest amount of ash, while the stems contained the highest level of CF. WL contained higher levels of potassium, calcium, iron, magnesium and copper than WH and GG. Silage pH was lower for the WL silages than for the other silages and was also lower for urea than for other N sources. The Lowest pH was obtained when WL was supplemented with 20% maize using blood meal or urea as N sources. Silage fermentation was better for WH and WL than for GG. The percent in vitro dry matter digestibility (IVDMD) was higher ($P<0.05$) for the WH and WL silages than for the GG silages with no difference ($P>0.05$) between the WH and WL silages. IVDMD for the various hays followed the trend WL>GG>WH ($P>0.05$). The percent in situ dry matter digestibility (ISDMD) for the various hays followed the trend WL>GG>WH ($P>0.05$).

Introduction

The menace of aquatic weeds and the adverse effects on aquatic environment constitute serious worldwide problem challenging international communities. Water hyacinth (*Eichormia crassipes*) is regarded as the most noxious of all aquatic weeds and has exhibited the most spectacular example of explosive infestation (Little, 1969 and Becker et al., 1987). Water lettuce (*Pistia stratiotes*) is another notorious tropical aquatic weed. The use of herbicides and mechanical removal are the most common methods for aquatic weed control; however; both methods are expensive. The high cost of mechanical removal of aquatic weeds could be acceptable if the harvested weeds could be incorporated into livestock diets to produce edible animal products. Several workers have investigated the use of aquatic weeds as livestock feeds (Boyd, 1974; Bates and Hentges, 1976). However, data obtained are mostly insufficient as most work reported so far have been on water hyacinth only and have sometimes been contradictory. There is also a general lack of information on the amount and value of the mineral components of acquatic weeds.

The nutrient composition of acquatic weeds vary widely depending on season, location and level of nutrification (Gerloff et al. 1965; Boyd, 1968; and 1972). Little and Henson (1967) observed that acquatic weeds contain low levels of dry matter (generally between 5 and 15%) while in contrast, terrestial forages contain 10 - 30%

solid. Roza and Khan (1981) pointed out that the high water content of the green mass coupled with the low energy content of the solid resulted in a reduction in daily dry matter, energy and protein intake, and also led to weight loss in animals fed solely with water hyacinth. Baldwin (1975) successfully conserved water hyacinth as silage for sheep. However, the low levels of fermentable carbohydrates in aquatic weeds (N. A. S., 1976) coupled with the high moisture content may result in butyric acid fermentation and spoilage of silages containing high levels of these weeds.

The objectives of this study were: (a) to evaluate the chemical composition of water hyacinth and water lettuce as compared with guinea grass; (b) to establish the level of maize supplementation which will provide the optimum amount of fermentable carbohydrates in water hyacinth and water lettuce silages; (c) to determine the most suitable protein supplement for the aquatic weed silages; and (d) to determine the in vitro digestibility by sheep and in situ digestibility by cattle of the aquatic weed silages and forages using guinea grass as contol.

Materials and Methods

Chemical and mineral analyses, ensiling, in vitro and in situ digestion studies were conducted to evaluate the nutritive characteristics of water hyacinth and water lettuce for ruminants using guinea grass (a typical tropical terrestial forage) as control.

Chemical Analyses

Water hyacinth (WH) and water lettuce (WL) were randomly collected from two separate locations (during December, 1987) in lush green condition. The samples were washed free of debris and placed in large plastic containers filled with water during transit in order to minimize water loss. Guinea grass (GG) was harvested between the sixth and seventh weeks of regrowth. Five kilograms of each fresh forage was dried in an oven at 60^{oc} for 72h. Other samples (10 kg each) of WH and WL were separated into leaves, stems and roots (WL contained no stem), and each plant part was separately dried. After drying, each sample was cooled in a dessicator, ground in a Wiley mill (20 mesh screen) and analyzed for dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE) and ash as described by the Association of Official Agricultural Chemists (AOAC) (1975). Nitrogen-free extract (NFE) was obtained by subtracting the sum of the percentages of CP, CF, EE, ash and moisture from 100. Organic matter (OM) was obtained by the difference between the percentage DM and percentage ash. Gross energy was determined using a ballistic bomb calorimeter.

Mineral Analyses

Dried forage samples (2g each) of WH, WL and GG were ashed in a Gallenkamp muffle furnace at 650^{oc} of 3h and allowed to cool in a dessicator. After cooling, 5 ml of 6N hydrochloric acid was added to each sample and filtered through a No. 1

Whatman filter paper into 100ml volumentric flask. The extract was washed thrice with distilled water, made up to 100ml and analyzed for phosphorus using a Pye Unicam SPG-450 UV/VIS spectrophotometer. Sodium and potassium contents were determined on a flame photometer. The concentrations of calcium, manganese, magnesium, iron and copper were determine using an atomic absorption spectrophotometer.

Studies on water hyacinth, water lettuce and guinea grass silages ensiled in laboratory silos.

Fresh forage samples of WH, WL and GG were chopped (into about 0.3 cm) and sun-wilted to about 40% DM. Three different protein supplements (groundnut cake, blood meal or urea) and three levels of maize (0, 10 or 20%) were added to each forage sample. The level of cane molasses was fixed at 5% and each silage was formulated to contain 15% CP. Duplicate samples were prepared for each of the 27 different silages. Each silage (150g DM basis) was hand packed tightly and uniformly in triple-layered polyethylene bags which served as laboratory silos. All edges and openings were sealed with masking tape and the contents were fermented for 28 days.

After fermentation, each silage sample was analyzed for the proximate components using the AOAC (1975) procedure. Other portions were subjected to a hand press and the pH of the fluids extracted were determined using a pH meter. Lactic acid content of the fluids were determined using the British Pharmacopoeia (1980) procedure. The remaining silage samples were dried, ground and kept in plastic containers for latter in vitro incubation.

In vitro digestion studies:

Triplicate samples (0.5g) of each dried and ground forage and silage were used as substrates for in vitro fermentation. Rumen fluids for the in vitro incubations were obtained from two rumen fistulated West African dwarf rams maintained on a diet containing 20% each of WH, WL and GG hays and 40% of a commercial concentrate for two weeks prior to the first collection in order to adapt the rumen microbes. Rumen fluids were collected 2h after the morning feeding into a pre-warmed thermos bottle (39^{oC}) using a Hauptner-Solinger rumen pump. Closed in vitro incubations were conducted by the method described by Aderibigbe (1980). Inoculum consisted of 50 ml of a mixture of one part rumen liquor, one part of a nutrient buffer solution (Mc Dougall, 1948) and two parts distilled water. Fermentation was conducted for 48h

In situ digestion studies

Triplicate (5.0g) samples of each dried and ground forage were used as substrates for the in situ digestion studies in two crossbred bulls fitted with rumen cannulae. The animals had been previously adapted (for 14 days) to a diet containing 10% each of brewers dried grain, groundnut cake, *Cliricidia sepium*, WH and WL hays, 45% GG hay, 4% cane molasses and 1% bone meal. The substrates were weighed into nylon bags (195 by 105mm) and incubated in the rumen of the experimental animals for 48h using the method described by Orskov et al. (1980).

Statistical Analyses

Data for the in vitro rumen digestibility of the silages were analyzed using a 3 X 3 X 3 factorial design described by Steel and Torrie (1980). Those for in vitro and in situ rumen digestibilities of the various forages were analyzed by the use of a one-way analyses of variance described by Neter and Wasserman (1977). Means were compared using Duncan's New Multiple Range Test described by Steel and Torrie (1980).

Results and Discussion

Chemical Analyses:

The chemical composition of the aquatic weeds and terrestial forage (whole plants) are shown on table 1. WH and WL contained lower DM than GG. Several researchers have observed similar low DM contents in Aquatic weeds (Little and Henson, 1967; NAS, 1976; Dutta et al., 1984; and Reddy et al., 1985). Thus, aquatic weeds must be dried in some manner if appreciable amounts of the material is to be consumed by livestock. The gross energy contents of the aquatic weeds were also lower than that of GG. Reza and Khan (1981) observed similar low energy content of acquatic weed solids. The aquatic weeds contained higher levels of CP than GG. This finding agrees with the results of Taylor and Robbins (1968) who reported that acquatic weeds contained between 10 and 26% CP which was equivalent to or higher than those of terrestial forages. Between the two aquatic weeds, CP content was higher for WL than of WH.

The ash contents of the aquatic weeds were higher than that of GG and were substantially higher than those found in most conventional livestock diets. This high level of ash in acquatic weeds may result in mineral toxicity in animals consuming substantial quantities of the weeds for extensive periods. The aquatic weeds contained lower CF than GG indicating that they are of better nutritive value since Aderibigbe et al. (1982) had observed that CF was negatively related to the palatability and nutritive value of forages. Table 2 shows the chemical composition of the various plant parts of the aquatic weeds. Most of the CP of WH and WL were located in the leaves while most of the ash were located in the roots. Thus, the leaves of these weeds could serve as protein concentrates in livestock diets while the roots could be used as sources of minerals.

Mineral Analyses

The results of the analyses of the experimental forages for eight different minerals are shown on table 3. The trends for K Mg and Fe contents of the forages were in

TABLE 1: CHEMICAL COMPOSITION OF WATER HYACINTH, WATER LETTUCE AND GUINEA GRASS FORAGES (WHOLE PLANTS)

Item	Water hyacinth (WH)	Water lettuse (WL)	Guinea grass (GG)
Dry matter (DM, %)	10.2	5.2	33.1
Gross energy (kcal/g of DM)	2.2	2.6	3.5
Analyses, % of DM			
Organic matter (OM)	57.0	63.4	89.4
Crude protein (CP)	11.3	15.4	6.7
Crude fiber (CF)	11.7	15.0	30.2
Ether extract (EE)	3.4	3.4	4.4
Ash	43.0	36.6	10.6
Nitrogen-free extract (NFE)	30.6	29.6	48.1

TABLE 2: CHEMICAL COMPOSITION OF THE VARIOUS PLANT PARTS OF WATER HYACINTH (WH) AND WATER LETTUCE (WL)

Item	Plant parts					
	Leaves		Stem		Roots	
	WH	WL	WH	WL[a]	WH	WL
Dry matter (DM, %)	16.0	5.0	5.6	-	15.4	8.8
Analyses, % of DM						
Organic matter (OM)	85.7	73.7	75.1	-	22.8	47.6
Crude protein (CP)	25.2	18.3	11.7	-	4.9	11.3
Crude fiber (CF)	15.4	14.3	20.9	-	3.6	18.0
Ether extract (EE)	4.1	3.8	4.2	-	0.4	1.6
Ash	14.3	26.3	25.0	-	77.2	52.4
Nitrogen-free extract (NFE)	41.0	37.3	38.2	-	13.9	16.7

[a] Water lettuce had no stem.

TABLE 3: ANALYSES OF WATER HYACINTH, WATER LETTUCE AND GUINEA GRASS FOR EIGHT DIFFERENT MINERALS

	Sample		
Mineral concentration (ppm)	Water hyacinth	Water lettuce	Ginea grass
Calcium (Ca)	1,804	6,594	4,545
Phosphorus (P)	791	1,108	3,030
Potassium (K)	46,060	72,524	2,257
Magnesium (Mg)	3,114	3,305	2,952
Sodium (Na)	3,784	2,043	174
Manganese (Mn)	222	156	212
Iron (Fe)	2,557	6,717	213
Copper (Cu)	20	31	26

TABLE 4: CRUDE PROTEIN (%) OF WATER HYACINTH, WATER LETTUCE AND GUINEA GRASSS SILAGES SUPPLEMENTED WITH DIFFERENT NITROGEN SOURCES AND VARIOUS LEVELS OF MAIZE

	Silage and nitrogen source								
	Water hyacinth (WH)			Water lettuce (WL)			Guinea grass (GG)		
Level of maize (%)	Groundnut cake	Blood meal	Urea	Groundnut cake	Blood meal	Urea	Groundnut cake	Blood meal	Urea
0	$18.3^{b,d}$	$18.1^{b,d,e}$	$16.8^{a,e}$	$15.4^{a,d}$	$15.8^{a,d}$	$16.3^{a,d}$	$14.6^{a,d}$	$14.9^{a,d}$	$15.1^{a,d}$
10	$18.9^{b,d}$	$18.8^{b,e}$	$15.7^{a,d}$	$16.4^{a,e}$	$17.1^{a,e}$	$17.4^{a,e}$	$16.4^{b,e}$	$15.1^{a,d}$	$14.7^{a,d}$
20	$18.5^{c,d}$	$17.0^{b,d}$	$15.9^{a,e}$	$16.7^{b,e}$	$15.4^{a,d}$	$16.6^{a,b,e}$	$14.1^{a,d}$	$15.1^{b,d}$	$16.3^{c,e}$

^{a,b,c} Means with a different superscript in each row for each silage differ ($P<0.05$).

^{d,e} Means with a different superscript in each column differ ($P<0.05$).

the other: WL>WH>GG. The K content of WL was higher than the value obtained for any other mineral analyzed. The trends for Ca and Cu contents of the forages were in the order: WL>GG>WH. The levels of P in the forages followed the trend GG>WL>WH while Na contents were in the order: WH>WL>GG. The forages contained low levels of Cu and Mn. The level of Ca observed for WH in this study was lower than those observed by several researchers (Baldwin, 1975; Surat and Singh, 1980; Dutta et al., 1984; and Reddy et al., 1985). This explains the lower Ca: P ratio (2.3:1) obtained in this study compared with that (10.7:1) observed by Baldwin (1975). Thus, the mineral content of aquatic weeds may be a direct reflection of the mineral content of the water medium from which the plants are harvested.

Silage studies

The percent CP of the silages after ensiling (table 4) were generally higher than the 15% value before ensiling. Among the various silages, percent CP after ensiling followed the trend WH>WL>GG. Aderibigbe and Church (1987) pointed out that higher levels of CP in silages generally indicate more intense fermentation of the non-protein components (assuming no loss of NH_4). This is probably the case in this study. There was no specific relationship between either the level of maize supplementation or the source of nitrogen and the CP content of the silages.

The pH of the silages after ensiling (table 5) were generally lower for the WL silages than for the other silages indicating more intense fermentation. Silage fermentation is normally associated with a low pH value (<pH5), provided the substrate has enough fermentable carbohydrate. In general, the silages did not undergo as much fermentation as expected probably due to insufficient fermentable carbohydrate since silage pH generally decreased with increasing levels of maize supplementation. The pH of the silages were slightly lower when urea served as the nitrogen source than for the other nitrogen sources.

The lactic acid content (molar percent) of the various silages are shown on table 6. Lactic acid (LA) content of the silages were higher for the WL silages than for the other silages indicating that they were of better quality. The LA content of the silages generally increased with increasing levels of maize supplementation irrespective of silage type or protein source. The highest LA content among all silages was obtained when WL was supplemented with 20% maize using urea as the nitrogen source.

In vitro and in situ digestion studies

The coefficients of in vitro dry matter digestibility (IVDMD) for the various silages are shown on table 7. IVDMD of water hyacinth silages supplemented with either groundnut cake or blood meal increased with increasing levels of maize while those supplemented with urea decreased with increasing levels of maize (P<o.o5). The highest IVDMD value for the WH silages was obtained when blood meal served as the nitrogen source using 20% maize. There was no specific relationship between the

TABLE 5: PH OF WATER HYACINTH, WATER LETTUCE AND GUINEA GRASS SILAGES SUPPLEMENTED WITH DIFFERENT NITROGEN SOURCES AND VARIOUS LEVELS OF MAIZE

	Silage and nitrogen source								
	Water hyacinth (WH)			Water lettuce (WL)			Guinea grass (GG)		
Level of maize (%)	Groundnut cake	Blood meal	Urea	Groundnut cake	Blood meal	Urea	Groundnut cake	Blood meal	Urea
0	$6.3^{a,d}$	$6.3^{a,f}$	$6.2^{a,f}$	$5.8^{b,d}$	$5.2^{a,d}$	$5.0^{a,d}$	$5.8^{a,c}$	$5.8^{a,c}$	$5.7^{a,c}$
10	$5.8^{a,c}$	$5.8^{a,d}$	$5.7^{a,d}$	$4.9^{a,c}$	$4.8^{a,c}$	$4.8^{a,c,d}$	$6.4^{a,d}$	$6.3^{a,d}$	$6.3^{a,f}$
20	$5.6^{a,b,c}$	$5.4^{a,c}$	$5.3^{a,c}$	$4.7^{a,c}$	$4.6^{a,c}$	$4.6^{a,c}$	$6.0^{a,c}$	$6.2^{a,d}$	$6.0^{a,d}$

^{a,b} Means with a different superscript in each row for each silage differ ($P<0.05$).

^{c,d,f} Means with a different superscript in each column differ ($P<0.05$).

TABLE 6: CONCENTRATION OF LACTIC ACID (MOLAR %) FROM WATER HYACINTH, WATER LETTUCE AND GUINEA GRASS SILAGES SUPPLEMENTED WITH DIFFERENT NITROGEN SOURCES AND VARIOUS LEVELS OF MAIZE

	Silage and nitrogen source								
	Water hyacinth (WH)			Water lettuce (WL)			Guinea grass (GG)		
Level of maize (%)	Groundnut cake	Blood meal	Urea	Groundnut cake	Blood meal	Urea	Groundnut cake	Blood meal	Urea
0	$3.2^{a,d}$	$3.5^{a,d}$	$4.5^{b,d}$	$5.4^{a,d}$	$5.8^{a,d}$	$5.5^{a,d}$	$5.4^{b,f}$	$5.4^{b,f}$	$4.9^{a,f}$
10	$5.2^{a,e}$	$5.3^{a,b,e}$	$5.7^{a,d}$	$6.3^{a,e}$	$7.1^{b,e}$	$8.6^{c,e}$	$3.5^{a,b,d}$	$3.3^{a,d}$	$3.8^{b,d}$
20	$6.7^{a,f}$	$7.3^{b,f}$	$7.6^{b,f}$	$8.7^{a,f}$	$8.8^{a,f}$	$9.1^{b,f}$	$4.5^{a,e}$	$4.4^{a,e}$	$4.4^{a,e}$

^{a,b,c} Means with a different superscript in each row for each silage differ ($P<0.05$).

^{d,e,f} Means with a different superscript in each column differ ($P<0.05$).

TABLE 7: IN VITRO RUMEN DRY MATTER DIGESTIBILITY (IVDMD,%) OF WATER HYACINTH, WATER LETTUCE AND GUINEA GRASS SILAGES SUPPLEMENTED WITH DIFFERENT NITROGEN SOURCES AND VARIOUS LEVELS OF MAIZE

	Silage and nitrogen source								
	Water hyacinm (WH)			Water lettuce (WL)			Guinea grass (GG)		
Level of maize (%)	Groundnut cake	Blood meal	Urea	Groundnut cake	Blood meal	Urea	Groundnut cake	Blood meal	Urea
0	$30.0^{a,d}$	$44.3^{b,d}$	$51.3^{c,f}$	$45.2^{a,d}$	$44.2^{a,d,e}$	$61.2^{b,e}$	$63.8^{c,f}$	$39.4^{a,f}$	$54.1^{b,f}$
10	$51.3^{b,e}$	$56.0^{b,e}$	$42.2^{a,e}$	$57.1^{c,e}$	$41.6^{b,d}$	$32.8^{a,d}$	23.2^{d}	24.7^{e}	25.5^{d}
20	$54.6^{b,e}$	$74.9^{c,f}$	$34.9^{a,d}$	$43.6^{a,d}$	$50.2^{a,b,e}$	$57.6^{b,e}$	$37.0^{b,e}$	$13.6^{a,d}$	$46.5^{c,e}$

^{a,b,c} Means with a different superscript in each row for each silage differ ($P<0.05$).

^{d,e,f} Means with a different superscript in each column differ ($P<0.05$).

TABLE 8: COMPARISON OF THE MEAN VALUES OF IN VITRO DRY MATTER DIGESTIBILITY (IVDMD, %)) OF WATER HYACINTH, WATER LETTUCE AND GUINEA GRASS SILAGES CONTAINING VARIOUS LEVELS OF MAIZE IRRESPECTIVE OF NITROGEN SOURCES

	Silage		
Level of maize	Water hyacinth (%)	Water lettuce (WH)	Guinea grass (GG)
0	$41.9^{a,c}$	$50.2^{a,c}$	$52.4^{a,d}$
10	$49.8^{b,c,d}$	$43.8^{b,c}$	$24.5^{a,c}$
20	$54.8^{b,d}$	$50.5^{b,c}$	$32.4^{a,c}$

^{a,b} Means with a different superscript in each row differ ($P<0.05$).

^{c,d} Means with a different superscript in each column differ ($P<0.05$).

TABLE 9: COMPARISON OF THE MEAN VALUES OF IN VITRO DRY MATTER DIGESTIBILITY (IVDMD, %) OF WATER HYACINTH, WATER LETTUCE AND GUINEAGRASS SILAGES CONTAINING DIFFERENT NITROGEN SOURCES IRRESPECTIVE OF LEVLES OF MAIZE

	Silage		
Nitrogen Source	Water hyacinth (WH)	Water lettuce (WL)	Guinea grass (GG)
Groundnut cake	$45.3^{a,d}$	$48.7^{a,d}$	$41.4^{a,e}$
Blood meal	$58.4^{c,e}$	$45.3^{b,d}$	$25.9^{a,d}$
Urea	$42.8^{a,d}$	$50.4^{a,d}$	$42.0^{a,e}$

^{a,b,c} Means with a different superscript in each row differ ($P<0.05$).

^{d,e} Means with a different superscript in each column differ ($P<0.05$).

level of maize supplementation and IVDMD of the WL silages. However, the highest IVDMD values were obtained when urea served as the nitrogen source using either 0 or 20% maize. IVDMD of GG silages containing 0% maize were higher than those of other silages irrespective of nitrogen sources. The highest IVDMD for the GG silages was obtained when groundnut cake served as the nitrogen source using 0% maize.

Table 8 shows the comparison of the mean values of IVDMD of the different silages containing various levels of maize irrespective of nitrogen sources. There were no significant differences (P>0.05) among the IVDMD of the different silages at 0% of maize supplementation. However, IVDMD of WH and WL silages were higher (P<0.05) than those of GG silages at 10 and 20% levels of maize supplementation. IVDMD of WH silages increased with increasing levels of maize supplementation. There was no specific relationship between IVDMD and levels of maize supplementation for either the WL or GG silages.

The comparison of the mean values of IVDMD of the various silages containing different nitrogen sources irrespective of levels of maize are shown on table 9. There were no significant differences (P>0.05) among the IVDMD of the various silages when groundnut cake or urea served as the nitrogen sources. However, IVDMD followed the trend: WH>WL>GG (P<0.05) when blood meal served as the nitrogen source. Although there were no significant differences (P>0.05) among the IVDMD of WL silages using the different nitrogen sources, IVDMD of the WH silages followed the trend: blood meal> groundnut cake = urea (P<0.05), while those of the GG silages followed the trend: urea = groundnut cake > blood meal (P<0.05). The overall means of IVDMD of the different silages irrespective of nitrogen sources or levels of maize were 48.8, 48.1 and 36.4% for WH, WL and GG, respectively. The values for WH and WL were significantly higher (P<0.05) than that of GG with no difference (P>0.05) between the WH and WL values. Thus, WH and WL silages are more digestible to sheep than GG silages. The percent in vitro and in situ dry matter digestibilities of WH, WL and GG hays are shown on table 10. The coefficients of both IVDMD of the various hays followed the trend WL>GG>WH (P<0.05), indicating that WL hay contained a higher level of digestible nutrients for ruminants than WH or GG hay.

Conclusions

This study has provided some useful information about the nutritive value of aquatic weeds for ruminants. Aquatic weeds contain lower amounts of DM and gross energy than terrestial forages indicating that the weeds must be dried in some manner and supplemented with high energy feed ingredients if appreciable amounts of the material is to be consumed by livestock. Aquatic weeds contain high levels of ash which may result in mineral toxicity in animals consuming substantial amounts of the weeds for extensive periods of time. Most of the CP of aquatic weeds are located in the leaves while the ash contents are mostly located in the roots. WH and WL silages are more digestible to sheep than GG silages. In vitro and in situ digestibilities of WL hay by ruminants were higher than those of WH or GG hay.

TABLE 10: IN VITRO (BY SHEEP) AND IN SITU (BY CATTLE) DIGESTIBILITIES OF WATER HYACINTH, WATER LETTUCE AND GUINEA HAYS

Item	Water hyacinth (WH)	Hay	
		Water lettuce (WL)	Guinea grass (GG)
Percent in vitro dry matter digestibility (IVDMD, %)	42.4^a	62.5^c	52.0^b
Percent in situ dry matter digestibility (ISDMD, %)	50.7^a	89.7^c	73.3^b

^{a,b,c} Means with a different superscript in each row differ ($P<0.05$).

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