Assessment of nutritive values of some waterweeds

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Abstract

The potentials of water weeds as a feed resource material in livestock production industry in Nigeria is yet to be fully exploited. The nutritive values of ten identified water weeds (*Polygonum lanigerum*, *Nymphaea lotus*, *Paspalum scrobiculatum*, *Ascroceras zizanioides*, *Ipomea aquatica*, *Panicum sulbabidum*, *Sacciolepis africana*, *Leersia hexandra*, *Heteranthera callifolia and Dicksonia antartica*) were therefore evaluated by determining their chemical composition and antinutritional components. The crude protein content ranged from 13.67% to 32.67% in *Paspalum scrobiculatum* and *Heteranthera callifolia* respectively while the crude fibre composition ranged between 4.00 % and 26.00 % in *Ipomea aquatica* and *Acroceras zizanioides* respectively. The neutral detergent fibre was generally high and it is between 37.33% in *Nymphaea lotus* and 64.00 % in *Panicum sulbabidum*. The antinutritional factor result showed that only four of the weeds contain saponin where only *Nymphaea lotus* and *Acroceras zizanioides* do not contain phenols or tannin. Steroids were present in all except *Nymphaea lotus* which contains the saturated steroids or triterperoids. The study showed that the water weeds had low antinutritional values and adequate amounts of nutrients which could be utilized by animals. Thus, the plants could be fed to livestock especially during the dry season as a source of plant protein.

Keywords: Water weeds, Saponins, Tannins, Steroids.

1. Introduction

Aquatic plants are floating species of plants and found at surfaces of water bodies. Many aquatic plants play significant role in biodegradation of agricultural and industrial wastes which are illegally dumped in water bodies. Their relevance are enormous likewise the nuisance they constitute which include blockage of water ways and hampering national development. Aquatic plants are conspicuous in Nigerian water ways, rivers, lakes and streams, and are deemed as weed with hindrances experienced by local fish farmers and large cargo ships.

The period of dry season is always a stressful one for livestock and associated with insufficient feed which invariably results in low animal output and production (Babayemi, 2007). The seasonality of forage production and low quality feeds especially in the tropics was reported by Humphreys (1991) as the major concern to researchers. Although, certain tree legumes have been proved to support and sustain ruminants as supplement in the dry season (Lazier, 1984; Roger, 2002), there are also aquatic weeds which are yet to be efficiently explored as feedstuffs for livestocks in Nigeria. This is perhaps due to their unidentified nutritive values and relevance in livestock feeding.

Geographically, the natural grassland occupies the larger percentage of the land mass which allows for the vast growing and cultivation of upland forages with little or no attention to the waterweeds. Nevertheless, literature revealed that in recent years, attention is now drawing to exploring the potentials of waterweeds. While agro industrial products and by-products as well as leguminous plants have been extensively utilized in ruminant's nutrition with relative success in animals maintenance and production the use of potentially nutritive waterweeds is yet to be given much attention or relevance.

Aquatic plants have prospective as a feed resource in countries with rivers, streams, swamps and dams (Babayemi et al., 2006). Many varieties of water plants are located in almost all the regions of Nigeria, worthy of mention are; *Polygonum lanigerum, Nymphaea lotus, Paspalum scrobiculatum, Acroceras zizanioides, Ipomea aquatica, Panicum subalbidum, Sacciolepis africana, Leersia hexandra, Heteranthera callifolia, and Dicksonia antartica.*

It has been observed that during the dry season, availability of nutritive forages for livestock is scanty due to long period of drought, resulting into unfavorable growth responses and reduced productive performances of the animals. Therefore there is need to enhance the readily available resources with other nutritive sources, as well as exploration of alternative feed resources of good nutritional quality and availability in animal nutrition particularly during the dry season becomes absolutely imperative. Utilization of aquatic plants in ruminant nutrition and production, on account of their nutrient composition and uninterrupted availability represents one of such approaches. It is necessary to pay adequate attention to problems relating to the feeding of animals during extended periods of dry season because this is the only way they could survive, remain healthy and offer products and by-products for man use. Therefore, the study was carried out to evaluate the nutritive values and phytochemical constituents of some commonly accessible waterweeds and their potential usage in livestock production.

1.1 Materials and Methods

1.1.1 Sample collection

Fresh samples of waterweeds were collected from water bodies in two locations, namely asero and Obantoko-Osiele road, Abeokuta, Ogun state, Nigeria. Samples were taken to COPLANT (College of Plant Science and Crop Production) laboratory of the Federal University of Agriculture, Abeokuta for identification purposes. Following identification, the weeds were weighed and immediately oven dried at 65^{o}C to a constant weight for dry matter determination.

1.1.2 Chemical Analysis

After drying and subjection to particle size reduction, triplicate chemical composition was carried out on each sample according to method of AOAC (1990). Dried meals were milled through a 1 mm screen. Ash was determined after ignition in a muffle furnace at 500± 15^{o}C for 4 h. Crude protein (CP) was estimated from N determined using a Kjeltec 2300 Analyser Unit (Kjeltec auto distillation unit, model: Kjeltec 8200) after samples were digested in concentrated sulphuric acid. Ether extract (EE) was determined by using petroleum ether (bp 60–80^{o}C) extraction in a Soxhlet extracting system .Crude fibre (CF) was determined using fibertec cold extraction unit.

The neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were determined as reported by Van Soest *et al.,* (1991).

1.1.3 Qualitative Determination of Saponin, Phenols and Steroids

Saponin, phenols and steroids were determined according to procedure of Babayemi et al., 2004. 2 g of sample was extracted with 30 ml petroleum ether and 25 ml methanol water (MW, 9/1, v/v). The mixture was shaken at 250 revolutions per minute for 1.5 h, filtered and separated by a funnel. The lower (MW) and upper layers were emptied into 50 ml volumetric flask each.

From the MW fraction, 1.67 ml was dispensed in 9 ml distilled water, filtered and from this; 1 ml was taken into a test tube. The test tube was shaken for 30 seconds and left to stand for 15 minutes. Saponin content was evaluated from the height of the foam layer as negative (< 5 mm), low (5 - 9 mm), medium (10 – 14mm) and high (> 15 mm).

Phenol analysis: 1 ml from the MW fraction was dispensed into five bottles with 1 % FeCl3 (w/v) added at different levels (0.2, 0.4, 0.6, 0.8 and 1 ml respectively). Phenols form complexes with ferric iron, resulting in a blue solution and hence, their presence was scored as: no phenols (no colour change), hydrolyzable (dark-blue) and condensed tannins (dark-green).

Steroids: 10 ml from the PE fraction was evaporated in a water bath at 45oC and 0.5ml chloroform, 0.25 ml acetic anhydride and 0.125 ml conc. H2 SO4 were added. The mixture was agitated briefly and the colour reaction was accessed as being steroids (blue or green), triterpenoids (red, pink or purple) or saturated steroids (light yellow).

1.1.4 Statistical analysis

Data obtained were subjected to One-way Analysis of Variance (ANOVA) in Completely Randomised Design. Significant differences among treatment means were determined using Duncan Multiple Range Test (Duncan, 1955) as contained in SAS (2010) package.

Results and Discussion

Table 1 shows the chemical composition of the water weeds. The percentage dry matter in the water weeds ranged between 11.67 to 26.67 % with the lowest and highest obtained in Heteranthera callifolia and Polygonum lanigerum. respectively. These were higher than the 5-9% reported for some waterweeds (Khan et al., 2002). The high moisture content of the plants might be a limiting factor in feeding them to ruminants or monogastrics on fresh basis; therefore this must be improved by dehydrating the harvested plants (Babayemi et al., 2006). Water bodies, Temperature, seasonal or climatic factors may be responsible for the variation in the dry matter content (Agriculture, 2011).

The crude protein was highest in Heteranthera callifolia (32.67%) and lowest in Paspalum scrobiculatum (13.67%). On a dry matter basis, aquatic weeds generally contain 10 to 26 % of crude protein, a range similar to that found in terrestrial plants. However, the average crude protein content of water weeds was higher than the majority of commonly available grass in the study areas including the Panicum maximum and Pennisetum purpureum with the average CP content of 6-11%. (Babayemi, 2007). Aquatic weeds are good source of protein and as such, these may be integrated into the diet of livestock. The crude protein obtained in aquatic plants was found to be richer than that obtained in terrestrial forages (Boyd, 1968). Protein content being the most valued component of any feed/feedstuff, cautious consideration must be paid to protein content of aquatic plants when it is considered for usage. The crude protein in waterweeds is adequately high to meet the protein requirement of livestock feeding and high protein in the diets especially if forages should be desired as it largely determines intake and digestibility.

The crude fibre content of the waterweeds was generally low with the lowest value of 4.00 % in Ipomea aquatic and the highest in Ascroceras zizanioides (26.00 %) when compared to 33.9 % obtained for Pennisetum purpureum (NRC, 1981) but was still in line with 10-15 % range obtained from the study of some waterweeds by Lange (1965). Fibre finds great relevance in animal nutrition especially in ruminants since it represents the plant cell wall used up as an energy source by the rumen microflora. The crude fibre of the waterweeds sampled in this experiment was lower than that obtained in conventional forages (Mishra et al., 1987) and this is mainly due to its high moisture content to fibre content. This ratio (moisture to crude fibre) is probably due to water buoyancy. Aquatic plants replace some of the need for structural integrity with buoyancy properties for survival, thus resulting in lower fibre values than emergent plants.

The values for the ether extract were within the range of 8 to 11.33 %. Low ether extract value of 8 % was obtained in Paspalum scrobiculatum, Acroceras zizanioides and Panicum subalbidum. Ether extract is the lipid component and the energy derived from it is utilized by the animal for body maintenance and production. The ether extract in the study then suggests that these aquatic plants are low in energy and therefore, must be supplemented with energy sources (Babayemi and Bamikole, 2006a) for animals to meet up the amount needed animals for normal body maintenance and production purposes. Ether extract becomes more relevant where caloric or energy values of feeds are primarily derived from fats and fatty acids content of the material. This suffices as aquatic plants appear to contain less extractable ether than terrestrial plants.

Ash denotes the mineral level in a feed, which contains majorly phosphorus, calcium, or potassium and large amount of silica (Verma, 2006). The highest ash content obtained in the study was found in Nymphaea lotus (26.00 %) while the lowest was in Polygonum lanigerum, Paspalum scrobiculatum and Dicksonia antartica (7.33 %) respectively. Ash content is established to inversely reflect the energy content of forages; the lower the ash value the higher the caloric value of the plant material. Ash content of aquatic weeds has been found to vary on account of location and season than it does in terrestrial plants. Since ash content signifies the mineral levels it then implies that when supplying these waterweeds to ruminants, (except the Nymphaea lotus) the diets may have to be fortified with mineral supplement. The ash values recorded in this experiment were higher than that obtained for tree fodders (Sandoval-Castro, et al., 2005) and in Panicum maximum and Newbouldia leavis

(Yusuf et al., 2013).

The nitrogen-free extract which signifies the carbohydrate content has its highest value of 56.00 % in Panicum subalbidum and its lowest value in Nymphaea lotus and Heteranthera callifolia (30.00 %). These values are possibly a true reflection of the crude fibre values obtained.

The neutral detergent fibre was within the range of 24-61% and 17-61% stated for fodders by Topps (1992) and Budi and Wina (1995) respectively, except for Sacciolepis Africana, Leersia hexandra and Paspalum scrobiculatum which had 61.33, 63.33 and 64.00 % respectively. Neutral detergent fibre represents the measure of the structural portion of plants and it majorly contains cellulose, hemicellulose and lignin. It is also the fibre fraction of plant which correlates to feed intake in animals. The high crude protein and the medium content of neutral detergent fibre in the waterweeds probably present them as complete diets for ruminants and compounding feed for some monogastric animals (rabbit). The acid detergent fibre in the waterweeds ranges between 20% and 51.33 %(Dicksonia antartica) with the highest lignin also in the Dicksonia antartica (27%) while the lignin values are low and are within the range of 4.23 and 12.23 %.

Table 2 shows the qualitatively determined secondary metabolites of the waterweeds. These metabolites are known to sustain bioactive actions in plants (Akinpelu and Kolawole, 2004). It was observed that all the waterweeds except Nymphaea lotus contain steroids.

Nymphaea lotus which contained saturated steroids or triterperoids was observed to contain neither saponin and tannin or phenols. Nymphaea lotuscan can therefore be included in diets of animals (ruminants and rabbits) with minimal or problem of animal rejecting it, as presence of saponin in diets can reduce plant palatability or predispose them to life threatening diseases (Foerster, 2006).

All the waterweeds contain condensed tannin except Acroceras zizanioides and the Nymphaea lotus. Tannins are beneficial to ruminants as it forms complex with protein in the rumen, thereby escaping the degradation by proteolytic enzymes (Babayemi and Bamikole, 2006). Tannin does not co-exist with saponin, because the surfactant properties of saponins negate the anti-digestibility effects of tannins (Freeland et al., 1985).

Conclusion

From the study it could be concluded that water weeds had adequate amounts of nutrients which could be utilized by animals. Thus, the plants could be fed to livestock especially during the dry season when forage feeds are generally scarce and as a source of leaf protein in monogastric feeding. The low to moderate antinutritional content of anti- nutrition value showed that they are safe for livestock consumption but its inclusion can also be enhanced.

Further research into seasonal variation and plant age as it influences chemical constituent variation. This will further help to determine the best period of harvesting and usage time. Feeding trials to determine the voluntary intake, digestibility and nutrient utilization of these water weed is recommended in ruminant and monogastric animals (poultry inclusive).

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Table 1: Chemical composition of (g/100g DM) of water weeds

Waterweeds	DM	CP	CF	EE	ASH	NFE	NDF	ADF	ADL
PL	26.67^{a}	27.00^{c}	12.00^{f}	11.33^{a}	7.33^{e}	42.00^{d}	53.33^{c}	20.00^{i}	5.23^{f}
NL	16.67^{c}	25.00^{d}	9.33^{h}	9.33^{b}	26.00^{a}	30.00^{g}	37.33^{g}	25.33^{h}	6.23^{e}
PSc	22.67^{b}	13.67^{g}	25.33^{b}	8.00^{c}	8.00^{e}	44.67^{c}	64.00^{a}	42.00^{c}	12.23^{b}
AZ	14.67^{d}	20.33^{e}	26.00^{a}	8.00^{c}	13.33^{c}	32.00^{fg}	54.00^{c}	31.33^{e}	4.23^{g}
IA	12.67^{e}	31.33^{b}	4.00^{i}	11.33^{a}	12.00^{d}	41.00^{d}	43.33^{e}	28.00^{g}	11.23^{c}
PSu	17.67^{c}	15.67^{f}	13.33^{e}	8.00^{c}	7.33^{e}	56.00^{a}	38.00^{g}	33.33^{d}	5.23^{f}
SA	14.67^{d}	25.67^{d}	20.00^{d}	10.00^{b}	11.33^{d}	32.67^{f}	61.33^{b}	32.00^{e}	4.23^{g}
LH	23.33^{b}	19.67^{e}	22.00^{c}	9.33^{b}	12.00^{d}	37.00^{e}	63.33^{a}	44.00^{b}	4.23^{g}
HC	11.67^{e}	32.67^{a}	12.00^{f}	10.00^{b}	15.33^{b}	30.00^{g}	39.33^{f}	29.33^{f}	9.23^{d}
DA	17.67^{c}	20.33^{e}	11.33^{g}	10.00^{b}	7.33^{e}	51.00^{b}	51.33^{d}	51.33^{a}	27.23^{a}
SEM	0.38	0.30	0.21	0.21	0.26	0.65	0.28	0.24	0.15

$^{a, b, c, d, e f, g, h, I:}$ Means in the same row with different superscripts differ significantly ($P<0.05$)
SEM: Standard Error of Mean
DM-dry matter, CP-crude protein, CF-crude fibre, EE-ether extract, NFE-nitrogen free extract, NDF-neutral detergent fibre, ADF-acid detergent fibre and ADL-acid detergent lignin.
PL-*Polygonum lanigerum*, NL-*Nymphaea lotus*, PSc-*Paspalum scrobiculatum*, AZ-*Acroceras zizanioides* IA-*Ipomea aquatica*, PSu-*Panicum subalbidum*, SA-*Sacciolepis africana*, LH-*Leersia hexandra*, HC-*Heteranthera callifolia*, DA-*Dicksonia antartica.*

Table 2: Anti-nutritional factors of water weeds

Waterweeds	Saponins	Phenols	Steroids/Tripteroids
Polygonum lanigerum	Negative	Condensed tannin	Steroids
Nymphaea lotus	Negative	No tannin	Saturated steroids
Paspalum scrobiculatum	Negative	Condensed tannin	Steroids
Acroceras zizanioides	Low saponin	No tannin	Steroids
Ipomea aquatica	Negative	Condensed tannin	Steroids
Panicum subalbidum	Low saponin	Condensed tannin	Steroids
Sacciolepis Africana	Low saponin	Condensed tannin	Steroids
Leersia hexandra	Negative	Condensed tannin	Steroids
Heteranthera callifolia	Low saponin	Condensed tannin	Steroids
Dicksonia antartica	Medium saponin	Condensed tannin	Steroids