A SHORT REVIEW OF THE FEEDING VALUE OF WATER PLANTS

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A short review of some experiments with water hyacinths, azolla and duckweed as cattle feed s described.

Although most of the experiments have been over short periods of time and with a small number of animals, they are uniform in showing water plants to be useful - maybe very useful - in combinations with feeds of poorer quality such as rice straw, intake, nitrogen retention and weight gain have been reported to go up.

For water hyacinth, dry matter production figures of 168 t/ha/year have been reported.

There appears to be a strong case for more systematic work on water plants in feeding trials over longer periods of time. For all the water plants, cultural practices, seasonal availability and manure requirements need to be established.

Key words: Livestock feeds, water plants, azolla, water hyacinth, duckweed

Records on the productivity of water plants are few. For water hyacinth (*Eichhornia crassipes*) Bates and Hentges (1976) reported figures as high as 168 t/ha/year and Wolverton and McDonald (1979) estimated maximum annual productivity to be 154 t/ha, The plant is co on in many countries and is seen everywhere in Bangladesh; it is often in the way of river traffic. It is commonly used as a forage for cattle and has been suggested as a "good quality" forage which could be used as a supplement to a basal diet of sugar cane, sisal pulp or molasses, and possibly also cereal straws. (Preston personal communication). In vitro, Juul-Nielsen (1981) found the rate of fermentation faster and also the digestibility higher in diets of untreated straw compared to diets with straw treated with 3% NaOH. Straw constituted 55% of the diet. Part of the explanation offered was that easily digestible cellulose is important as a starting substrate for the cellulolytic bacteria and that once the environment is created for them they will provide the ruminant with sufficient nutrients through the process of fermentation even if the bulk of the feed is of low digestibility, like straw, Water plants usually have the advantage of being high in protein, unlike many high yielding tropical forages (Gaffer 1981).

As suppliers of dry matter, ""god forage", starting substrate for cellulolytic bacteria or protein, water plants appear to have a role to play in feeding of ruminants. Some experiments have already been carried out, and a few of them will be briefly reviewed,

Some experimental results

Gupta et al (1975) observed that water hyacinth hay alone was not well accepted by bullocks, but when the diet offered on a DM basis consisted of 2.7 kg water hyacinth, 0.3 kg ground nut cake and 2.3 kg rice straw, the bullocks gained 10 ± 4.6 kg over a period of 32 days. The intake of the ration was low at 1.25 ± 0.06 kg/100 kg

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bodyweight. There were 4 bullocks in the experiment.

In another trial by the same workers (Gupta et al 1975), water hyacinth was mixed with rice straw in a proportion of 4:1 and ensiled for 135 days. In a feeding trial over 30 days, intake was of the order of that observed in the first trial, and the bullocks just maintained weight. The trend was similar and uniform for all 4 bullocks. They received small daily supplements of sesame oil cake of 100 to 320 g. 59% of the DM is estimated to have been from rice straw. Balances of nitrogen, calcium and phophorous were recorded to be positive in both experiments.

Khan (1977) found green water hyacinth alone insufficient for the maintenance of bullocks and over a period of 60 days the animals lost 1.4 kg. But feeding of green water hyacinth and dry rice straw in a proportion of 1:1 gave a recorded gain of 4.1 kg and an increase in intake of dry matter of 67%. Retention of nitrogen was also improved and the digestibility was recorded to increase from 61% to 67%. The addition of an oil cake (220g/d), to the second diet (water hyacinth, straw mix) increased the gain in weight to 5.9 kg and DM intake to 109% over the control group on water hyacinth alone.

El-Sarafy et al (1979) made similar observations with regard to intake of DM, digestibility (both in ViVo and in vitro) and nitrogen balance. They ensiled water hyacinth (sun dried for 4 days to a dry matter of 70%) mixed with rice straw (chopped), maize stalks (chopped),yellow maize (ground) and wheat bran (fine) at levels of 15 and 25%. In all cases 5% sugar cane molasses was added and ensiling was for 60 days. The results are reported in Table 1.

Table 1:

Dry matter intake, in vivo and in vitro digestibilities and nitrogen balance of water hyacinth silage mixtures fed to sheep (El-Serafy et al 1979).

Silage mixture	DM intake kg/d	DM digestibility (%) in vitro	DM digestibility (%) in vivo	Nitrogen balance g/d
Water hyacinth alone	Was not preserved satisfactorily - mould growth			
Water hyacinth + 5% molasses	0.52	41.9	56.8	-6.3
Water hyacinth + 5% molasses + {15% rice straw	0.63	50.9	59.6	-1.3
Water hyacinth + 5% molasses + {15% maize stalks	0.62	70.1	66.2	3.3
Water hyacinth + 5% molasses + {15% ground maize	0.71	72.8	67.2	5.2
Water hyacinth + 5% molasses + {15% wheat bran	0.65	53.1	62.3	-2.9
Water hyacinth + 5% molasses + {25% rice straw	0.74	70.4	66.5	2.3
Water hyacinth + 5% molasses + {25% maize stalks	0.75	40.8	58.8	3.3
Water hyacinth + 5% molasses + {25% ground maize	0.65	75.5	77.5	4.5
Water hyacinth + 5% molasses + {26% wheat bran	0.69	72.9	73.4	3.9

All the additives have caused an increase in intake when compared to the diet consisting of water hyacinths and 5% molasses. The 15% inclusion of any of the additives increased digestibility, whether in vitro or in vivo. At the 25% level of inclusion the same trend is observed, except for corn stalks in vitro. The consistently high level of digestibility (in vitro and in vivo) for all nutrients, when 25% rice straw is included, is of considerable practical interest. The rice straw and water hyacinths are both found in many tropical countries. This diet provides the animal with an additional 68% digestible DM, when both the increased intake and digestibility is included, compared with the water hyacinth/5% molasses control. As in the first experiment by Gupta et al (1975), the rice straw is estimated to have constituted around 40% of the total DM, at which there appears to be a level of very fruitful interaction between rice straw and water hyacinths. The nitrogen balance is strongly negative with water hyacinths and molasses alone at - 6.3 g/day. But it is improved to + 2.3 g/day when 25% rice straw is added. Rice straw normally contains only 0.5% nitrogen (Saadullah et al 1981), which excludes this as a supplier of additional nitrogen. 0rskov (personnel communication 1981) considers that the increased intake will increase microbial nitrogen production and that this increased microbial nitrogen production is also a result of a better rumen ecosystem and improved digestion. The digestibility of rice straw alone rarely exceeds 45% of DM (Saadullah et al 1981) and the digestibility of the water hyacinth plus 5% molasses is reported to be 41.9 in vitro and 56.8 in vivo (Table 1). But an addition of 25% rice straw increases intake and digestibility to 70.4 in vitro and 66.5 in vivo on the mixed diet with intake going up to 43%.

An explanation is difficult, but may be attempted along the following lines. A basic diet of water hyacinth/straw is a "good forage" helping to retain the digesta in the rumen and allowing greater ruminal degradation. Certain parts of the water hyacinth such as the leaves may have readily degradable cellulose, which is important for the activity of the cellulolytic bacteria (Juul-Nielson 1981) and the plant also has enough nitrogen for this activity. The strong negative N-balance when water hyacinth is fed alone also suggests a more rapid passage through the rumen without the straw in the diet.

On the basis of the works of Gupta et al (l975), Khan (1977) and El-Serafy et al (1979) it may thus be concluded that both water hyacinth and straw are made better use of when fed together. In work by the present authors, small quantities of water hyacinth were added to rice straw. The results are presented in Table 2.

The intake of water hyacinth on a DM basis was very low as water hyacinth only contains 5 to 10% DM. Assuming 10% DM, the water hyacinth contributed 5.5% of the DM of the total ration. In spite of this there is an increase in digestibility from 41 to 48% with an increase in intake. Adding urea and molasses increased both intake and digestibility so that 74% more digestible nutrients are provided to the animals.

Azolla and duckweeds: Table 3 reports on a comparison of azolla and a concentrate mixture as supplements to a diet of wheat straw and sugarcane tops mixed together (Singh 1980).

A 28 day trial by Rustoff et al (1978) compared an experimental diet of maize silage and duckweed species (*Spirodela polyrhiza, S.oliggorrhiza, Wolffia columbiana* and *Lemma gibba* -G3) fed at 2:1 on a DM basis with the control ration of 7 kg (fresh weight) maize silage, 2 kg of 18% CP concentrate plus free access to Dallas grass

pasture. 8 Holstein heifers of 225 ± 53 kg were split between treatments. Gains on the control ration were .51 ± 26 kg/ day compared with .95 ± .13 kg/day for the duckweed supplemented ration. The duckweed was reported to have an in vitro DM digestibility of 80 - 85% compared with 65% for the maize silage. The crude fibre of the duckweed was 11.1% and protein was 40.5% of the DM.

Table 2:

Effect of adding water hyacinth to a rice straw diet for sheep

No of sheep	Weight (kg)	Ration	DM intake g/kg $W^{0.75}$	Digestibility of DM (%)	N-balance g/ 24 hours
4	13.5 ± 0.5	Straw only	52.4 ± 1.8	41 ± 2.0	-2,5 ± 0.4
4	13.1 ± 0.6	Straw:water hyacinth (2:1)[1]	59.1 ± 1.0	48 ± 1.0	-2.8 ± 0.4
4	17.6 ± 2.0	Straw:water hyacinth (2:1)[1] plus urea and molasses[2]	66.5 ± 3.1	55 ± 1.0	+4.6 ± 0.5

[1] Fresh weight ratio of straw to water hyacinth fed (rice straw 85-90% DM; water hyacinth 5 - 10% DM)

[2] Urea and molasses was added to give 10% molasses and 2% nitrogen of ration DM

Table 3:

The comparative effect of supplements of concentrates[1] and Azolla[2] to a diet of wheat straw and sugarcane tops on the growth of crossbred heifers[3] (Singh 1980)

	Concentrate supplemented group	Azolla supplemented group
Intake of wheat straw + sugarcane tops (ad lib), kg DM/head/day	2.1	2.1
Supplement consumption, kg DM/head/day	1.5	0.9
Digestibility of organic matter of he diet, %	45	59
Daily liveweight gain, kg/head	0.14	0.33

[1] The concentrate mixture contained 65% maize, 15% ricebran, 16% groundnut cake and 4% minerals and salt. Protein content was 17%. The amount given to the animals was calculated to meet NRC (1971) requirements of energy and protein

[2] Azolla is a water plant, growing in stagnant village ponds and collected and dried. Protein content was 29%

[3] The heifers weighed 100 kg on an average at the begining of the trial

Conclusions

m e results presented in this review are uniform in showing water plants to be useful in combinations with feeds of poorer quality. However, the trials have generally been very short,and the results need to be confirmed in feeding trials over longer periods of time. An explanation of the results, that is,whether water plants are providers of "good roughage characteristics" easily digestible cellulose or bypass protein also need to be determined. Their low dry matter content and high digestibility , put them into the same category as sweet potato leaves and banana stems , but both azolla and duckweed equal *Leucaena leucocephala* as suppliers of protein per unit dry matter. For all the wafer plants, culture practices, seasonal availability and manure requirements need to be established.

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