Copyright © 2015 Scienceline Publication

Online Journal of Animal and Feed Research

Volume 5, Issue 2: 40-44; Mar 25, 2015 ISSN 2228-7701

NUTRITIVE VALUE OF WATER HYACINTH (*Eichhornia crassipes*)

Md. Emran HOSSAIN*[1], Hillol SIKDER[2], Md. Hossain KABIR[2] and Sabuj Manohar SARMA[2]

[1]*Department of Animal Science and Nutrition, Chittagong Veterinary and Animal Sciences University, Khulshi, Chittagong-4225, Bangladesh*
[2]*UG student, Faculty of Veterinary Medicine, Chittagong Veterinary and Animal Sciences University, Khulshi, Chittagong-4225, Bangladesh*
*Email: emrancvasu@yahoo.com

ABSTRACT*:* The study was undertaken to find out the chemical composition and nutritive value of Water Hyacinth (*Eichhornia crassipes*) available in Chittagong, Bangladesh. *Eichhornia crassipes* samples were collected from three different remote places of the study area. Chemical analyses of the samples were carried out in triplicate for dry matter (DM), crude protein (CP), crude fiber (CF), nitrogen free extracts (NFE), ether extracts (EE) and total ash (TA) in the animal nutrition and poultry research and training centre (PRTC) laboratory, Chittagong Veterinary and Animal Sciences University, Chittagong, Bangladesh. Metabolizable energy (ME) was estimated mathematically for all samples by using standard formula. Results indicated that, there were no significant variations (P>0.05) in the DM, CP, CF, NFE, EE and TA contents of the samples collected from different places. DM content varied from 8.7 to 9.3 g/100g, CP content varied from 10.1 to 11.2 g/100g, CF content varied from 26.1 to 27.4 g/100g, EE content varied from 1.1 to 1.8 g/100g, NFE content varied from 47.2 to 50.2 g/100g and TA content varied from 12.3 to 12.4 g/100g. Similarly, metabolizable energy (ME) content also varied from 1999.7 to 2054.1 Kcal/kg DM. It could therefore be inferred that, the nutrient contents of *Eichhornia crassipes* does not vary due to variation in geographical location. Nutritionally, *Eichhornia crassipes* seems sound enough to be utilized as feed for livestock especially during scarcity period.

Keywords: Chemical Composition, *Eichhornia crassipes*, Metabolizable Energy, Nutritive Value.

ORIGINAL ARTICLE
pii: S222877011500007-5
Received 05 Jan. 2015
Accepted 20 Feb. 2015

INTRODUCTION

Water hyacinth (*Eichhornia crassipes*) is a cosmopolitan invasive aquatic plant which can tolerate a wide range of environmental conditions such as temperature, humidity, illumination, pH, salinity, wind, current and drought. The plant is morphologically plastic with a rapid mode of vegetative propagation that makes it well adapted to a long distance of dispersal and colonization under diverse ecological conditions. It is one of the most prolific aquatic plant which spreads at an alarming rate. It has spikes of light blue flowers and green color roundish leaves with inflated bladder like petioles. The extremely rapid rate of proliferation of *Eichhornia crassipes* results reduced penetration of dissolved oxygen in water body, change in water chemistry, disruption of aquatic flora and increased rate of water loss due to evapotranspiration. Therefore, it is considered as a serious threat to biodiversity and recently massive attention has been given to its harvesting for use as alternative plant protein source for livestock.

In Bangladesh, cattles are fed mainly low quality roughage including natural grazes and agro-industrial by products such as straw, sugarcane by-products and other crop residues. These feeds are deficient in protein, energy, minerals and vitamins. At certain time of the year, quality of grazing deteriorates due to seasonal influence. Thus livestock productivity consequently declines and in this case lactation ceases unless supplements are offered. Availability of livestock feeds are decreasing day by day in Bangladesh due to shortage of grazing area. In such cases, water hyacinth, a very common and locally available unconventional feed may be a good alternative to overcome feed crisis.

In Bangladesh, huge amount of *Eichhornia crassipes* are produced due to large number of rivers, ponds, lakes and other water reservoirs. In many coastal areas of the country, *Eichhornia crassipes* is commonly used as

To cite this paper: Hossain M.E., Sikder H., Kabir M.H. and Sarma S.M. 2015. Nutritive value of water hyacinth (Eichhornia Crassipes). *Online J. Anim. Feed Res.*, 5(2): 40-44.
Scienceline/Journal homepages: http://www.science-line.com/index/; http://www.ojafr.ir

forage for cattle either as basal feed resource or supplement to a diet consists of sugarcane, molasses and cereal straws. About 60% or more ponds and rivers are covered by water hyacinth in Chittagong district and almost all of them are being used by the farmers without any nutritional knowledge on it. If the chemical composition and nutritive value of *Eichhornia crassipes* can be explored, the farmers can utilize them as an unconventional feed for their livestock to minimize feed cost and maximize production. Therefore, current study was undertaken to find out the chemical composition and nutritive value of *Eichhornia crassipes* available in Chittagong, Bangladesh.

MATERIAL AND METHODS

Study area

Eichhornia crassipes are available all over Bangladesh. However, the study was carried out in three remote areas i.e., Khulshi, Raozan and Fatikchari of Chittagong district. There were sufficient ponds, water reservoirs and low lands in the study area for collection of *Eichhornia crassipes*.

Collection of sample

Eichhornia crassipes samples were collected from different ponds, water reservoirs and low lands of Khulshi, Raozan and Fatikchari area. Immediate after collection, roots were cut-off and removed, fresh stalks and leaves were collected and packed into air tight polythene sacs and sent to the animal nutrition laboratory, Chittagong Veterinary and Animal Sciences University, Chittagong, Bangladesh for chemical analysis.

Preparation of samples

Fresh samples were chopped to 3.0 cm in length and mixed uniformly. Mixed samples were subjected to hot air oven for estimation of dry matter. The remaining samples were sundried for about 7 days at an environmental temperature of 22.8-33.8°C and relative humidity of 54.0-96.0%. Approximately 500 g of dried, uniformly ground samples were collected for proximate analysis.

Chemical analyses

Chemical analyses of *Eichhornia crassipes* samples were carried out in triplicate for dry matter (DM), crude protein (CP), crude fiber (CF), nitrogen free extracts (NFE), ether extracts (EE) and total ash (TA) in the Animal Nutrition laboratory, Chittagong Veterinary and Animal Sciences University, Chittagong as per AOAC (2006).

Estimation of ME

All samples were subjected to proximate analysis in triplicate. Later on, Metabolizable energy (ME) content in all the water hyacinth samples was estimated by using a standard mathematical formula as per Lodhi et al. (1976).

Data analysis

Data related to chemical composition and nutritive value of *Eichhornia crassipes* were compiled by using Microsoft Excel 2007. Chi-square (χ^2) test was performed to analyze the data by using SPSS 16.0 (Winer et al., 1991). Statistical significance was accepted at 5% level ($P<0.05$).

RESULTS AND DISCUSSIONS

Eichhornia crassipes belongs to Kingdom-Plantae, Order-Commelinids, Family-Pontederiaceae, Genus-Eichhoria and Species-crassipes. In present study, *Eichhornia crassipes* contained low DM (9.3%), moderate CP (10.5%) and CF (26.9%) high NFE (48.7%) and TA (12.4%). These observations are in well agreement with other investigators (Aboud et al., 2005; Boyd, 1968; Dada, 2002; Dairo, 1997; Gollamudi et al., 1984; Mako and Babayemi, 2008; Okoye et al., 2002; Reza and Khan, 1981). The level of CP available in *Eichhornia crassipes* may be considered favorable for feeding ruminant and may be considered as a valuable supplement for low quality crop residues (Aboud et al., 2005). Previous reports indicated that, light green leaves and petioles of *Eichhornia crassipes* contained higher percentage of protein than those of the mature plant (Men et al., 2006). The leaf contains more protein than sweet potato leaf (An et al., 2003) while the protein content in entire plant is higher than traditional grasses such as elephant grass (Hong et al., 2003). Therefore, *Eichhornia crassipes* can be supplemented in low quality diets (Khan et al., 2002). Leaf proteins of *Eichhornia crassipes* are rich in glutamine, asparagine and leucine (Virabalin et al., 1993). Chemical composition of *Eichhornia crassipes* is influenced by season, type of habitat (Poddar et al., 1991; Tham, 2012; Tucker and Debusk, 1981) as well as harvesting frequency (Reddy and D'Angelo, 1990). In tropical condition, the plant matures more rapidly (Buxton, 1996) and cell walls become highly lignified (Van Soest, 1988). Crude protein concentration is high in the immature forage but

To cite this paper: Hossain M.E., Sikder H., Kabir M.H. and Sarma S.M. 2015. Nutritive value of water hyacinth (Eichhornia Crassipes). *Online J. Anim. Feed Res*., 5(2): 40-44.
Scienceline/Journal homepages: http://www.science-line.com/index/; http://www.ojafr.ir

declines as maturity advances (Buxton, 1996). Lignin and silica are the most important limiting factors for digestibility of *Eichhornia crassipes* (Van Soest, 1981). Lignin content of *Eichhornia crassipes* varied from 7 to 10% while silica varied from 0.5 to 5% (Abdelhamid and Gabr, 1991; Biswas and Mandal, 1988). *Eichhornia crassipes* grown in sewarage had high crude protein and ash contents (Wolverton and McDonald, 1978) compared with ponds, rivers and lakes. High content of ash in water hyacinth is probably due to accumulation of minerals absorbed from water (Boyd, 1968).

Eichhornia crassipes is very popular recently as animal feed, aqua feed, water purification, fertilizer, biogas production, even food for human and other products (Ogle et al., 2001; Wolverton and McDonald, 1976). Water hyacinth can be used as fresh, ensiled or wilted for feeding animals. Whole plants either, chopped or ground can be used as feedstuffs for both ruminants and monogastrics (Tham, 2012). *Eichhornia crassipes* contains high levels of cellulose and hemicellulose, which could serve as energy sources for ruminants (Mukherjee and Nandi, 2004). Fresh *Eichhornia crassipes* can be utilized as partial replacement of para grass (Brachiaria mutica) in diets of cattle (Biswas and Mandal, 1988; Thu, 2011). Supplementation of wilted *Eichhornia crassipes* in a rice straw-based diet has positive effect on intake and growth of beef cattle (Islam et al., 2009). In a study, daily live weight gain was approximately 500 g when 30% dried *Eichhornia crassipes* was included in the basal diet of wheat straw at a fixed amount of concentrates (Parashar et al., 1999). Since *Eichhornia crassipes* has very low dry matter content, wilting is preferred to reduce silage losses (McDonald et al., 2011). *Eichhornia crassipes* can be ensiled successfully with addition of molasses, rice bran, cassava root as well as organic acids. Silage prepared with *Eichhornia crassipes* has well acceptance by ruminants (Tham, 2012). An ensiled mixture of *Eichhornia crassipes*, rice straw, urea and molasses was fed to dairy cattle and resulted an increase of milk yield (Chakraborty et al., 1991; Tham, 2012). Utilization of both wilted and ensiled *Eichhornia crassipes* as a feed for sheep was reported (Abou-Raya et al., 1980; Baldwin et al., 1975). Although wilted *Eichhornia crassipes* has not been recommended as the sole feed for sheep, however, it could replace up to 50% of the concentrates in complete diets (Abdelhamid and Gabr, 1991). *Eichhornia crassipes* residues, after mechanical extraction of the juice, can be used in the diet of fattening buffalo calves (Borhami et al., 1992). While *Eichhornia crassipes* accounted for 35% of diet, then feed conversion efficiency was higher compared to a similar level of Egyptian clover (Trifolium alexandrinum).

Chemical composition of *Eichhornia crassipes* varies with regard to habitat, density and season (Poddar et al., 1991; Tucker and Debusk, 1981). Highest CP and lowest ADF were obtained in the winter at the time of lowest growth rates. As DM productivity increased in warmer weather, CP levels decreased and ADF content increased (Tucker and Debusk, 1981). In another report, higher concentrations of nitrogen were accumulated in the shoots of *Eichhornia crassipes* than in its roots, whereas nitrogen accumulation was similar in the roots and shoots of water lettuce (Agami and Reddy, 1990; Tham, 2012). It was evident that, roots were supposed to hold more Zn than other parts of *Eichhornia crassipes* (Rupainwar et al., 2004). Insect damage also reduced the concentrations of nitrogen and P in plants growing in high nutrient water (Heard and Winterton, 2000). *Eichhornia crassipes* is a good source of crude fat. Gollamudi et al. (1984) reported that fat in water hyacinth was primarily found in leaves (14.9 g/100g) whereas roots and stalks contained 1.6 and 0.9 g/100g respectively.

The improvement of crude protein intake and digestibility has been seen when increasing levels of fresh *Eichhornia crassipes* was incorporated in cattle diets (Tham, 2012). However, to avoid bloat and low intake of rice straw, the level of fresh water hyacinth in diet should not exceed 30% for growing cattle. Nutrient digestibility increased with increasing level of ensiled water hyacinth offered (Tham, 2012). It seemed likely that ensiled *Eichhornia crassipes* at levels of at least 50% of the diet had the potential to supply enough metabolisable energy for better live weight gains of >300 g/day in cattle.

Table 1 - Chemical composition and nutritive value of Water Hyacinth (*Eichhornia crassipes*) available in Chittagong, Bangladesh

Parameters	Chemical composition (g/100gDM)						
	DM	CP	CF	Ash	EE	NFE	ME (Kcal/kg)
Khulshi area	9.3	10.3	27.4	12.4	1.1	48.8	1999.7
Raozan area	8.7	10.1	26.1	12.3	1.3	50.2	2054.1
Fatikchori area	9.8	11.2	27.4	12.4	1.8	47.2	2028.5
Mean	9.3	10.5	26.9	12.4	1.5	48.7	2032.6
Std. Deviation	0.5	0.5	0.6	0.1	0.3	1.2	22.4
Sig.	NS	NS	NS	NS	NS	NS	NS

DM=Dry matter; CP=Crude protein, CF=Crude fibre, NFE=Nitrogen free extract, EE=Ether extract; NS=Non-Significant (P>0.05)

To cite this paper: Hossain M.E., Sikder H., Kabir M.H. and Sarma S.M. 2015. Nutritive value of water hyacinth (Eichhornia Crassipes). *Online J. Anim. Feed Res*., 5(2): 40-44.
Scienceline/Journal homepages: http://www.science-line.com/index/; http://www.ojafr.ir

CONCLUSION

Eichhornia crassipes is available all over the country almost round the year. *Eichhornia crassipes* contains moderate CP, high NFE and TA. It contains adequate mineral that is sufficient for maintenance and production requirement of cattle. These imply that the plant can be utilized as feed for animals especially ruminants. It is also reported that the proximate composition of water hyacinth is almost similar to other perennial grasses available in Bangladesh. *Eichhornia crassipes* naturally absorbs pollutants including toxic chemicals like lead and others as well as some organic compounds believed to be carcinogenic in surrounding water. Therefore, *Eichhornia crassipes* can assist farmers ensuring sustainable production of least cost diets for cattle. The sustainability of the least cost diet is expected eventually for successful management of the weed in water ways for protection of biodiversity. Therefore, more comprehensive studies are recommended to make it low cost, locally available conventional aquatic feed for livestock.

REFERENCES

Aboud AAO, Kidunda RS and Osarya J (2005). Potential of water hyacinth (E. Crassipes) in ruminant nutrition in Tanzania, Livestock Research for Rural Development, 17(8): 23-32.

Abou-Raya AK, Hathout MK, El-Talty YL and Abdel-Khabir AM (1980). Utilization of water hyacinth as animal feed: II. Evaluation of wilted shoots in metabolism trials with sheep with reference to N, Ca, Na and K balances. Agricultural Research Review, 58(6): 49-60.

Agami M and Reddy KR (1990). Competition for space between *Eichhornia crassipes* (Mart.) Solms and Pistia stratiotes L. cultured in nutrient-enriched water. Aquatic Botany, 38(2-3): 195-208.

An LV, Frankow-Lindberg BE and Lindberg JE (2003). Effect of harvesting interval and defoliation on yield and chemical composition of leaves, stems and tubers of sweet potato (Ipomoea batatas L. (Lam.)) plant parts. Field Crops Research, 82(1): 49-58.

AOAC (2006). Official Methods of Analysis. Association of Official Analytical Chemists. (18th ed). Gaithersburg, Maryland, USA.

Baldwin JA, Hentges JF, Bagnall LO and Shirley RL (1975). Comparison of pangolagrass and water hyacinth silages as diets for sheep. Journal of Animal Science, 40(5): 968-971.

Biswas P and Mandal L (1988). Use of fresh water hyacinth (*Eichhornia crassipes*) in the ration of growing calves. Indian Veterinary Journal, 65: 496-500.

Borhami BE, Zahran SM, Fahmy WG and Somaa A (1992). The utilization of protein extraction residues from berseem and water hyacinth for fattening buffalo calves. Buffalo Bulletin, 11(2): 40-43.

Boyd CE (1968). Fresh water plants. A potential source of protein. Ecological Botany, 22: 359-368.

Buxton DR (1996). Quality-related characteristics of forages as influenced by plant environment and agronomic factors. Animal Feed Science and Technology, 59(1-3): 37-49.

Chakraborty B, Biswas P, Mandal L and Banerjee GC (1991). Effect of feeding fresh water hyacinth (Eichhorinia crassipes) or its silage on the milk production in crossbred cows. Indian Journal of Animal Nutrition, 8(2): 115-118.

Dada SA (2002). The utilization of water hyacinth (*Eichhornia crassipes*) by West African dwarf (wad) growing goats. African Journal of Biomedical Research, 4: 147-149.

Dairo FAS (1997). Evaluation of water hyacinth (E. crassipes) as feed ingredient and yolk growing goats, African Journal of Biomedical Research, 4: 147-149.

Gollamudi LK, Rao S, Pantulu AJ and Thyagarajan G (1984). Composition of lipids in roots, stalks, leaves and flowers of *Eichhornia crassipes*, (Mart.) Solms, Aquatic Botany, 20: 219-227.

Heard TA and Winterton SL (2000). Interactions between nutrient status and weevil herbivory in the biological control of water hyacinth. Journal of Applied Ecology, 37(1): 117-127.

Hong NTT, Wanapat M, Wachirapakorn C, Pakdee P and Rowlinson P (2003). Effects of timing of initial cutting and subsequent cutting on yields and chemical compositions of cassava hay and its supplementation on lactating dairy cows. Asian-Australasian Journal of Animal Science, 16(12): 1763-1769.

Islam S, Khan MJ and Islam MN (2009). Effect of feeding wilted water hyacinth (*Eichhornia crassipes*) on the performance of growing bull cattle. Indian Journal of Animal Science, 79(5): 494-497.

Khan MJ, Steingass H, and Drochner W (2002). Evaluation of some aquatic plants from Bangladesh through mineral composition, in vitro gas production and in situ degradation measurements. Asian-Australasian Journal of Animal Science, 15(4): 537-542.

Lodhi GN, Daulat Singh and Ichhponani JS (2009). Variation in nutrient content of feedingstuffs rich in protein and reassessment of the chemical method for metabolizable energy estimation for poultry. Journal of Agricultural Science, 86(2): 293-303.

Mako A and Babayemi O (2008). Nutritional evaluation of water hyacinth as ruminant feed to curtail its environmental menace in Nigeria, African Journal of Livestock Extension, 6: 35-41.

McDonald P, Edwards RA, Greenhalgh JFD, Morgan CA, Sinclair LA and Wilkinson RG (2011). Animal Nutrition. 7th edn. Harlow, England, Pearson.

Men LT, Yamasaki S, Caldwell JS, Yamada R, Takada R and Taniguchi T (2006). Effect of farm household income levels and rice-based diet or water hyacinth (*Eichhornia crassipes*) supplementation on growth/cost performances and meat indexes of growing and finishing pigs in the Mekong Delta of Vietnam. Animal Science Journal, 77(3): 320-329.

Mukherjee R and Nandi B (2004). Improvement of in vitro digestibility through biological treatment of water hyacinth biomass by two Pleurotus species. International Biodeterioration and Biodegradation 53(1): 7-12.

Ogle BM, Dao HTA, Mulokozi G and Hambraeus L (2001). Micronutrient composition and nutritional importance of gathered vegetables in Vietnam. International Journal of Food Science and Nutrition, 52(6): 485-499.

Okoye FC, Daddy F and Ilesanmi BD (2002). The nutritive value of water hyacinth (Eichhorniacrassipes) and its utilisation in fish feed, Annual Report, National Institute for Fresh Water Fisheries Research (NIFFR), New Bussa.

Parashar SK, Rajora NK and Jain LS (1999). Utilization of water hyacinth (*Eichhornia crassipes*) by growing crossbred calves. Indian Journal of Dairy Science, 52(5): 320-323.

Poddar K, Mandal L and Banerjee GC (1991). Studies on water hyacinth (*Eichhornia crassipes*)-Chemical composition of the plant and water from different habitats. Indian Veterinary Journal, 68: 833-837.

Reddy KR and D'Angelo EM (1990). Biomass yield and nutrient removal by water hyacinth (*Eichhornia crassipes*) as influenced by harvesting frequency. Biomass, 21(1): 27-42.

Reza A and Khan JM (1981). Water hyacinth as cattle feed. Indian Journal of Animal Science, 51: 702-706.

Rupainwar DC, Rai S, Swami MSN and Sharma YC (2004). Uptake of zinc from water and wastewater by a commonly available macrophyte. International Journal of Environmental Studies, 61(4): 395-401.

Tham HT Water Hyacinth (*Eichhornia crassipes*)-Biomass Production, Ensilability and Feeding Value to Growing Cattle. PhD Thesis. Swedish University of Agricultural Sciences, Uppsala, 2012.

Thu NV (2011). Effects of water hyacinth (*Eichhornia crassipes*) in local cattle diets on nutrient utilization, rumen parameters and microbial protein synthesis. In: Proceedings of SAADC 2011 strategies and challenges for sustainable animal agriculture-crop systems, Volume III: full papers. Proceedings of the 3rd International Conference on sustainable animal agriculture for developing countries, Nakhon Ratchasima, Thailand, 26-29 July, 2011. Pp. 422-426.

Tucker CS and Debusk TA (1981). Seasonal growth of *Eichhornia crassipes* (Mart.) solms: Relationship to protein, fiber, and available carbohydrate content. Aquatic Botany, 11: 137-141.

Van Soest PJ (1981). Limiting factors in plant residues of low biodegradability. Agric. Env., 6(2-3): 135-143.

Van Soest PJ (1988). Effect of environment and quality of fibre on the nutritive value of crop residues. In: Reed JD (Eds.) Plant breeding and the nutritive value of crop residues.

Virabalin R, Kositsup B and Punnapayak H (1993). Leaf protein concentrate from water hyacinth. Journal of Aquatic Plant Management, 31: 207-209.

Winer BJ, Brown R and Michels KM (1991). Statistical Princi-ples in Experimental Design. McGraw-Hill, New York.

Wolverton B and McDonald RC (1976). Don't waste waterweeds. New Scientist, 318-320.

Wolverton BC and McDonald RC (1978). Nutritional composition of water hyacinths grown on domestic sewage. Economic Botany, 32(4): 363-370.

To cite this paper: Hossain M.E., Sikder H., Kabir M.H. and Sarma S.M. 2015. Nutritive value of water hyacinth (Eichhornia Crassipes). *Online J. Anim. Feed Res*., 5(2): 40-44.
Scienceline/Journal homepages: http://www.science-line.com/index/; http://www.ojafr.ir