Nigerian J. Anim. Sci. 2021, 23 (1): 214-218

Influence of maturity stage on nutritive value of typha for ruminants

Musa A.R. [+], de Evan T.[*], Makinde O.J.[+], Alao J.S.[+], Iglesias E. [†], Escribano F. [†], Carro M.D.[*], Aminu, M. [+], Dunya, A. M. [+], Mohammad. I. C. [+], Charles H.[+]

[*] *Department de Producción Agraria, ETSIAAB, Universidad Politécnica de Madrid, Madrid, Spain*
[+] *Department of Animal Science, Faculty of Agriculture, Federal University, Gashua, Nigeria*
[†] CEIGRAM, *ETSIAAB, Universidad Politécnica de Madrid, Madrid, Spain*

Corresponding Author**: mshmadrufai@gmail.com* ***Telephone Number: +2348037955918

Target Audience: *Agronomists, livestock farmers, nutritionists*

Abstract

The study evaluated the influence of maturity on the nutritive value and fermentation parameters of Typha. Typha samples were collected at two different stages of growth, as indicated by the height of the plants: either 0.5 m (Low Typha; LT, age 3-6months) or 1.5 m (High Typha; HT, age 9-12 months). Samples were analyzed for chemical composition, and incubated in vitro with ruminal fluid from sheep to determine the main fermentation parameters. As maturity advanced, the dry matter, fiber and lignin content (25.30%, 70.40%, 47.30% and 10.58%) in the Typha increased, whereas the content of ashes and protein (12.18% and 12.24%) decreases. The changes in chemical composition caused a significant reduction in both the in vitro ruminal degradability after 96 h of incubation (38.6 and 22.9% for LT and HT, respectively) and the production of volatile fatty acids after 24 h of incubation (6.08 and 5.87 mmol/g dry matter incubated), indicating that the nutritive value of the Typha declines with advancing maturity. The results indicate that Typha plants for ruminant feeding should be preferably harvested at early growth stages.

Key words: *Feeding, Maturity, Chemical composition, In vitro ruminal fermentation, Thypha domingensis*

Description of Problem

Thypha domingensis (Typha) is a colonizer plant that is a major problem in the Hadejia valley in Northern Nigeria due to its invasive growth. Typha growth affects negatively the productivity of rice fields, blocks water channels, impedes the flow of rivers, hinders navigation and fishing, increases flooding risks, and affects negatively the biodiversity of these ecosystems, favoring the persistence of waterborne diseases (4). Typha also known as cattail or bulrush is a plant locally known as *Kachalla* in Hausa. *Typha domingensis* is largely distributed in Northern Nigeria, but is essentially cosmopolitan, being found in a variety of wetland habitat. *Typha domingensis* is a herbaceous, rhizomatous perennial plant with long, slender, green stalks topped with brown and fluffy sausage shaped flowering head. *Typha domingensis* is often among the first wetland plants to colonize areas of newly exposed wet mud, with its abundant wind dispersed seeds. Its survives in the soil for a long period with buried seeds (4). The use of Typha in ruminant feeding, especially when feed availability is scarce, could contribute to improve the livestock performance and improve the sustainability of local livestock farms. However, information on its nutritive value is limited. One important factor affecting the nutritive value of forages for ruminants is their stage of maturity (7). The aim of this work was therefore to analyze the chemical composition and *in vitro* ruminal fermentation of Typha samples collected at different stages of growth.

Materials and Methods

Samples from Typha plants measuring 0.5 (LT; low Typha, age 3-6 months) and 1.5 m (HT; high Typha, age 9-12 months) were collected at Hadejia valley (Northern Nigeria) in June 2018. The collected plants were in the Hadejia riverside, immersed 30-40 cm in shallow water. It had young shoots without spike, small roots and no rhizomes developed (Figure 1). Whole plants were packed in plastic bags, that were closed to prevent water loses, and send to the laboratory of Animal Production, Universidad Politechnica de Madrid, Spain. Roots were separated and only the leaves and stem were used for the study, as described by de Evan et al. (2) in the framework of the World Bank-TRIMING Typha project (www.typhaproject.com). Plants from the same height were pooled to form 3 samples of each, dried (45ºC, 48 h) to determine dry matter (DM) content, and ground (1 mm pore size) before analysis of chemical composition using the AOAC procedures 2005 (1) and *in vitro* incubations. Four adult rumen-fistulated sheep were used as rumen fluid donors for the *in vitro* incubations to the main fermentation parameters. Experimental procedures were approved by the Animal Experimentation Ethics Committee of the Comunidad Autónoma de Madrid (Approval number PROEX 035/17).

Figure 1. Samples of Typha plant measuring 0.5 m (left picture) and 1.5 m (right picture).

Two hundred mg of dry matter (DM) of each sample were accurately weighed into 60 ml glass vials. Ruminal contents from each sheep were obtained immediately before the morning feeding, strained through 4 layers of cheesecloth, and mixed independently with the culture medium of Goering and Van Soest (6) in 1:4 proportion at 39ºC under CO_2 flushing. Vials were filled with 20 ml of the mixture, capped and incubated at 39ºC for 24 h. Gas production was measured using a pressure transducer and a calibrated syringe, the contents of the vials were homogenized and their pH was measured. Then, 2 ml of each vial content were taken and with 2 ml 0.5 M HCl for volatile fatty acid (VFA) and NH_3-N analyses. Four replicates per sample were obtained by using the ruminal fluid from the

four sheep independently. The ruminal degradability (RD) of the Typha was determined by weighing in triplicate 300 mg of each sample into Ankom Corp #57 bags (30 µm pore size; Ankom Technology Corp., Fairport, NY, United States). Bags were incubated in the mixture of ruminal fluid and the culture medium previously described in an Ankom Daisy II incubator at 39ºC under continuous rotation. After 96 h, the bags were washed with cold water, dried at 60ºC for 48 h, and weighed to calculate RD.

Statistical Analysis

Fermentation data were analyzed as a mixed model using the PROC MIXED of SAS, with the height of the Typha as fixed effect and that of the inoculum as random effect. The model for the analysis of chemical composition and RD data included only the fixed effect of Typha height. The significance level was set at $P < 0.05$, and $P < 0.10$ values were considered as trends.

Results and Discussion

As shown in Table 1, both typha plants had low DM content, which was lower in LT compared with the HT (15.8 and 25.3%, respectively; $P = 0.016$). The content in neutral detergent fiber (NDF), acid detergent fiber (ADF), cellulose and lignin increased ($P \leq 0.048$) with the height of the plant, whereas the content of ashes and crude protein (CP) tended to decrease ($P \leq 0.081$). In contrast, there were no differences ($P \geq 0.320$) between plants in hemicellulose and ether extract (EE) content. These changes in chemical composition are in agreement with the usual increase in fiber and decrease in CP protein reported for forages as they increase in maturity (2). For both plants, a great proportion (> 50%) of the CP was insoluble in neutral detergent, which indicated a low availability of the protein for the ruminant (7). The chemical composition of the HT agrees well with that reported by de Evan et al. (5) for a sample of Typha of 2 m height in the same zone of this study, that contained 25.8% of DM and 10.5, 8.84, 67.9 and 41.9% of ashes, CP, NDF and ADF, respectively (on DM basis). Wingching-Jones (6) reported lower DM content (14.6%) and slighlty lower CP, NDF and ADF contents (7.83, 61.8 and 37.0%, respectively) in a 4-month regrowth sample of typha from Costa Rica. More recently, Villacrés (7) reported contents of 12.0, 11.9, 69.1, 40.1, 6.69 and 4.84 % (DM basis) of ashes, CP, NDF, ADF, liginin and EE, respectively, for a pooled sample of typha plants of variable height collected at the South of Spain. Although factors such as plant maturity, soil characteristics, climate, etc. can influence typha chemical composition, all these results indicate that typha has low DM, but the DM contains medium CP and high NDF and ADF levels.

The *in vitro* ruminal fermentation parameters and RD of the typha samples are shown in Table 2. The lower ($P = 0.008$) pH of the LT samples is consistent with the greater ($P = 0.013$) gas production and the trend to greater ($P = 0.075$) VFA production of these samples compared with the HT, because the ruminal pH declines as the production of VFA increases (2). The production of gas is directly related to the amount of organic matter fermented by rumen microorganisms (8), and the results indicate greater rumen fermentation of LT compared with HT. In fact, the greater RD values of the LT confirmed this hypothesis. There were differences between plants in the VFA profile, and the LT had greater ($P = 0.008$) acetate and lower ($P \leq 0.023$) butyrate, isobutyrate and isovalerate proportions than the HT. Both isobutyrate and isovalerate are used by the cellulolytic bacteria for their growth, and the lower concentrations of the two acids in the LT samples might indicate a greater growth of these bacteria, which is consistent with the greater VFA production. There were no differences between plants either in the acetate/propionate ratio or

in the NH_3-N concentrations, suggesting that ruminal degradation of the protein was not affected by the height of the typha.

Table 1. Chemical composition (% dry matter, unless otherwise stated) of Typha plants collected at different height (0.5 and 1.5 m)

	Typha height (m)			
Item	0.5 (LT)	1.5 (HT)	SEM [1]	*P* =
Dry matter (g/100 g fresh matter)	15.8	25.3	1.67	0.016
Ash	12.24	9.25	0.910	0.081
Crude protein (CP)	12.18	8.10	1.052	0.052
Neutral detergent fibre	68.3	74.0	1.35	0.039
Acid detergent fibre	40.8	47.3	1.27	0.023
Lignin	7.77	10.58	0.370	0.006
Hemicellulose	27.5	26.7	0.47	0.320
Cellulose	33.0	34.4	0.92	0.048
CP insoluble in neutral detergent solution (% of CP)	51.9	50.7	1.58	0.630
Ether extract	4.31	4.87	0.422	0.401

[1] SEM: standard error of the mean

Table 2. *In vitro* 24-h fermentation parameters of Typha plants collected at different height and *in vitro* ruminal degradability after 96 h of incubation with ruminal fluid from sheep

	Typha height (m)			
Item	0.5	1.5	SEM [1]	*P* =
Ph	.41	.52	0.02	0.008
Gas (ml/g dry matter)	4.8	0.1	1.3	0.013
Total VFA (mmol/g dry matter)	.08	.87	0.087	0.075
Molar Proportions (mol/100 mol)				
Acetate (Ac)	68.0	67.3	0.155	0.008
Propionate (Pr)	19.3	19.3	0.148	0.712
Butyrate	6.51	6.92	0.056	<0.001
Isobutyrate	2.46	2.66	0.042	0.003
Valererate	1.18	1.20	0.016	0.317
Isovalerate	2.53	2.63	0.029	0.023
Ac/Pr (mol/mol)	3.52	3.50	0.034	0.650
NH_3-N (mg/l)	25	21	4.7	0.519
Ruminal degradability (%)	8.6	2.9	1.84	0.004

[1] SEM: standard error of the mean

Conclusion and Applications

1. It can be concluded that the nutritive values of typha declines with advancing plant maturity. This is probably due to the observed increase in NDF and lignin content which is indigestible and reduces fiber digestibility.
2. Typha for ruminant feeding should be harvested at early growth stages.

Acknowledgements

Funding from the Technical University of Madrid (Plataforma Africa; Cooperation Funds), the Spanish MINECO (Project AGL2016-75322-C2-1-R), the Federal Ministry of Water Resources of Nigeria, and the World Bank (TRIMMING project: Transforming Irrigation Management in Nigeria) are gratefully acknowledged.

References

1. AOAC. Association of Official Analytical Chemists (2005). Official Methods of Analysis (18th. ed. 9th revision). Gaithersburg, MD, USA.
2. de Evan T., Marcos C.N., Carro M.D. Alao J.S., Makinde J.O., Rufai M.A., Iglesias E. and Escribano F. (2019). Nutritive value of typha for ruminants. *Book of Proceedings of the 44th Annual Conference of the Nigerian Society for Animal Production*. 48-50. Available at www.typhaproject.com
3. Goering, H.K. and Van Soest, P.J. (1970). Forage fiber analyses (apparatus, reagents, procedures, and some applications). In: Agricultural Handbook, Nº. 379. Agricultural Research Services, Washington DC, USA.
4. Iglesias, E., Loureiro, M.L., and Escribano, F. (2018). Conference Workshop AERNA 2018 Household perceptions on biogas as a sustainable energy source. A focus group study in Hadejia Valley, Nigeria.
5. Menke K.H., Raab L., Salewski A., Steingass H., Fritz D. and Schneider W. (1979). The estimation of the digestibility and metabolizable energy content of ruminant feed stuffs from the gas production incubated with rumen liquor. Journal of Agricultural Science, 93: 217-222.
6. Van Soest, P.J. (1994). *Nutritional Ecology of the Ruminant*, 2nd ed.; Cornell University Press: Ithaca, NY, USA.
7. Villacrés, R.A. (2020). Valoración nutritiva de ensilado de enea para los animales rumiantes. Master Thesis. Technical University of Madrid. Madrid, Spain.
8. Wingching-Jones, R. (2014). Valoración agronómica y nutricional Typha domingensis como alternativa de alimentación en animales rumiantes. Nutrición Animal Tropical, 8: 24–35.