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RESEARCH NOTE

CHEMICAL EVALUATION OF FRESH AND ENSILED WATER HYACINTH (*Eichhornia crassipes* (Mart.)) AS FEED FOR RUMINANTS

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ABSTRACT

The nutrient profile, phytochemical composition, and silage quality of water hyacinth (WH) were determined and compared to Napier grass (NG), a common forage in ruminant diets. Ensiling improved the nutrient profile of WH and NG because of the significantly higher (*P*<0.05) dry matter (DM) and crude protein (CP) and significantly lower (*P*<0.05) neutral detergent fiber (NDF) and moisture content (MC) of ensiled WH (EWH) and ensiled NG (ENG). Ether extract (EE) values were not significantly different (*P*>0.05). Qualitative phytochemical analyses indicated the presence of flavonoids and cardiac glycosides in WH, NG, EWH, and ENG. Tannins were present only in WH and NG however only ENG and NG contained saponins. Ensiled WH had pH values of 3.61 to 3.91 and lactic acid concentrations of 94.33 to 125.48 g/kg DM indicating good silage quality. Furthermore, EWH had better CP (11.07%) and NDF (47.37%) than WH (9.23% CP, 55.26% NDF), NG (6.21% CP, 71.02% NDF) and ENG (7.95% CP, 58.73% NDF) which most likely will favor better ruminal fermentation in ruminants. Therefore, based on these properties, EWH has the best potential as a substitute for NG in the Philippines.

Key words: nutrient profile, phytochemical composition, ruminants, silage quality, water hyacinth

INTRODUCTION

Water hyacinth is a perennial aquatic weed that colonized large areas of bodies of water in many countries. It impedes human activity and alters the ecological balance deterring the growth of beneficial organisms (Hossain *et al*., 2015). In the Philippines, the most plausible utilization of WH would be as animal feed for ruminants, along with other known roughage like Napier grass (*Pennisetum purpureum* Schum). However, WH is a high moisture forage making it prone to faster spoilage. The optimum way of preservation for high moisture forages in tropical countries is through ensiling (Moran, 2005). Hence,

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ensiling WH would be ideal to extend its shelf life.

Some studies showed the potential of WH and EWH as feed for non-ruminant and ruminant animals. Akankali and Elenwo (2018) stated that pigs fed with diets that consisted of 30% WH exhibited low feed cost/body weight gain ratio and increased protein efficiency. Hossain *et al*. (2015) and Akinwande *et al*. (2016) had similar findings that 30% WH in the ruminant diet increased in vitro gas production. Furthermore, EWH inclusion in ruminant diets can increase CP intake and digestibility of organic matter, CP, NDF, and acid detergent fiber (Tham and Uden, 2013). Good growth performance was observed in sheep fed with 30% EWH diet (Thu, 2016).

This study aimed to chemically evaluate and compare WH, EWH, NG and ENG and to assess if WH and/or EWH can be a possible substitute to mature (56-day old) NG. The utilization of local WH species can introduce a new forage source for small scale farmers and consequently help control the spreading WH population.

MATERIALS AND METHODS

Mature WH samples, approximately one meter long, were collected at Laguna de Bay Los Baños while 56-day old NG samples were collected at the Dairy Training and Research Institute (DTRI). Silage preparation involved air-drying the cleaned, root-less samples for a day and sun-drying for half a day. Dried WH and NG were chopped separately and added with 5% w/w molasses. Twenty-eight replicates of 1.5 kg samples were vacuum-pressed and sealed in individual polyethylene bags for 21 days of silage fermentation. Silage quality was analyzed from 0 to 56 days after fermentation at a 7-day interval.

Proximate values of WH, NG, EWH and ENG were determined by standard procedures (AOAC, 1990) and NDF values were estimated using the method of Van Soest *et al*. (1991). Water-soluble carbohydrate (WSC) content determination and pH analysis followed the methods from AFIA (2011). Qualitative phytochemical analysis was adapted from the methods of Dubey *et al*. (2010), Isebe (2016) and Harborne (1998) and, the method of Borshchevskaya *et al*. (2016) was referenced for Lactic acid content determination. One-way analysis of variance (ANOVA) and Least significant difference (LSD) was performed on the nutrient analysis (MC, DM, CP, EE, NDF) of WH, NG, EWH, and ENG while a T-test with unequal variance was performed for WSC of WH and NG as well as for pH and lactic acid content values of EWH and ENG. The level of significance was set at $P<0.05$.

RESULTS AND DISCUSSION

Higher DM, CP, and ash content as well as lower MC and NDF content were observed in WH and NG after ensiling. Table 1 showed that ENG had the highest DM among the samples followed by EWH then NG, and lastly WH. Water hyacinth had higher CP than NG and ENG. However, EWH had the highest CP value among the samples but it cannot supplement enough protein (CP value at 16 to 18%) for proper rumen function according to Dung *et al*. (2014). Water-soluble carbohydrate (WSC) of WH and NG had no significant difference (P=0.0650) however both were in low amounts thus justifying the need to add molasses (5%w/w) for proper ensiling. Ensiling proved to have no effect on EE because all of its values were not significantly different (P=0.2567). EWH had the highest ash content indirectly correlating to high amounts of minerals. WH had lower NDF than NG and ENG however, EWH had the best NDF content because it was nearest to the 30% NDF value suggested by Allen (1996) for proper rumen function.

The pH values and lactic acid per day (Table 2) of EWH and ENG were not significantly different. Both the pH and lactic acid are within the range of 3.6 to 4.0 (AFIA, 2011) and 90-120 g/kg value (AFDA, 2016), respectively, showing that the silage of the study is of good quality. Table 3 showed that WH, NG, EWH and ENG have flavonoids and cardiac glycosides. Tannins were only found in WH and NG because of microbial degradation during ensiling. Jimenez *et al*. (2013) proposed that the species of lactic acid bacteria, *Lactobacillus plantarum*, degrades tannins via tannase and gallate decarboxylase. Saponins were only found in NG and ENG.

In conclusion, WH had higher CP and lower NDF compared to NG and ENG. However, EWH had the best nutrient content because it had the highest CP, and lowest NDF as

Table 1. Nutrient analysis values of Water Hyacinth (WH), Napier Grass (NG), Ensiled Water Hyacinth (EWH) and Ensiled Napier Grass (ENG).

Nutrient Analysis, %	**WH**	**NG**	**EWH**	**ENG**	**SEM**	***P*-value**
Moisture Content	90.84[a]	86.90[b]	82.35[c]	77.15[d]	1.54	<0.0001
Dry Matter	9.16[d]	13.10[c]	17.65[b]	22.85[a]	1.54	<0.0001
Crude Protein	9.26[b]	6.21[d]	11.07[a]	7.95[c]	0.54	<0.0001
Ether extract	1.58	1.12	1.88	1.69	0.14	0.2567
Ash	16.95[b]	11.01[d]	18.18[a]	11.90[c]	0.94	<0.0001
Neutral Detegent Fiber	55.26[c]	71.02[a]	47.37[d]	58.73[b]	2.57	<0.0001
Water-Soluble Carbohydrate	5.17	4.34			0.23	0.0650

Means of within the same row with different superscripts are significantly different at $P<0.05$.

Table 2. pH values and lactic acid content of Ensiled Water Hyacinth (EWH) and Ensiled Napier Grass (NG).

Day	**pH Values**		**SEM**	***P*-value**	**Lactic Acid Content, g/kg DM**		**SEM**	***P*-value**
	EWH	**ENG**			**EWH**	**ENG**		
0	3.61	3.66	0.0176	0.2300	125.47	107.73	4.691	0.0855
7	3.70	3.80	0.0260	0.0640	95.12	88.54	4.143	0.5014
14	3.72	3.82	0.0280	0.0643	94.64	91.27	3.268	0.6746
21	3.80	3.88	0.0261	0.1402	94.33	85.80	3.704	0.3072
28	3.76	3.85	0.0291	0.1116	110.55	88.83	6.146	0.0743
35	3.86	3.83	0.0108	0.2087	97.10	99.26	4.975	0.8563
42	3.89	3.81	0.0224	0.0867	103.52	96.05	5.672	0.5863
49	3.86	3.81	0.0263	0.4130	95.78	106.97	5.898	0.4470
56	3.91	3.87	0.0224	0.3971	101.74	95.00	4.796	0.5699

Table 3. Qualitative phytochemical analysis of Water Hyacinth (WH), Napier Grass (NG), Ensiled Water Hyacinth (EWH) and Ensiled Napier Grass (ENG).

Analysis	WH	EWH	NG	ENG
Tannins	+	-	+	-
Saponins	-	-	+	+
Flavonoids	+	+	+	+
Cardiac Glycosides	+	+	+	+

+/- presence or absence of the phytochemical

well as higher DM value than WH and NG. EWH and ENG had no significant differences in pH and lactic acid content per day indicating that WH and NG had similar quality when ensiled. EWH only had flavonoids and cardiac glycosides while WH had tannins, flavonoids, and cardiac glycosides. Therefore, based on these properties, both WH and EWH were possible feed substitutes however, EWH had the best potential to be a feed substitute to mature NG (56-days old).

Studies determining the concentration of phytochemicals and heavy metal in WH and/or EWH may also be considered in the future. Furthermore, a feeding trial is needed to see the effects of EWH on animal growth performance to confirm if EWH is indeed the best possible substitute for NG.

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