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Quality assessment of ensiled hybrid Napier grass by *in-vitro* fermentation techniques

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Abstract

The present study was conducted to evaluate silage made from hybrid Napier grass (*Pennisetum purpureum*) ensiled in the laboratory using various additives with regard to sensory and chemical characteristics. Four different silages were prepared *viz*., grass ensiled without additives (GS) as control, and grass silage with *Lactobacillus plantarum* at 1 x 10^5 CFU per gram of fresh forage (GSL), grass silage with propionic acid at the rate 0.45 kg per ton of fodder (GSA), and grass silage with combination of *Lactobacillus plantarum* (1 x 10^5 CFU per gram of fresh forage) and propionic acid (0.45 kg per ton of fodder) (GSLA). Silage was opened on 21 days of ensiling and assessed the sensory and chemical characteristics. From the overall results, it could be concluded that hybrid Napier grass, ensiled for 21 days using *L. plantarum* was effective in preserving its nutritive value.

Keywords: *In-vitro*; silage; hybrid Napier grass; *Lactobacillus plantarum*

1. Introduction

Silage making is a cost-effective method for preserving fodder, crucial for ensuring a steady supply of green fodder during lean periods (Stewart, 2011). However, nutrient loss during the ensiling process, limited knowledge of proper ensiling techniques and the time consumption for production process are significant barriers to silage production. Silage additives, such as bacterial inoculants and organic acids, are commonly used worldwide to enhance fermentation and minimise nutritional losses in stored feed. Identifying the most effective additives, their optimal combinations along with short preparation period can accelerate the production of high-quality silage, thereby supporting sustainable and profitable dairy farming (Kumar *et al.,* 2015). This pilot study aims to assess the quality of silage made from hybrid Napier grass, with and without additives, ensiled in the laboratory over a short duration of 21 days.

2. Materials and methods

2.1. Laboratory ensiling

Laboratory ensiling of fodder grass was done at Department of Animal Nutrition, College of Veterinary and Animal Sciences, Mannuthy. Hybrid Napier grass *(Pennisetum purpureum)* harvested at 45 days of maturity was procured from University Livestock Farm & Fodder Reseach Development Scheme, Mannuthy. *L. plantarum* and propionic acid (99 per cent pure) were used as silage additives for the 21 days laboratory ensiling process. The chopped grass (2 to 3 cm length) was filled into a strong high-density polythene bag (45×60 cm). Different types of grass silages prepared were GS (Grass ensiled without additive (control)), GSL (Grass + bacterial inoculum (1 x 10^5 CFU per gram of fresh forage), GSA (Grass + propionic acid (0.45 kg per ton of fodder)) and GSLA (Grass + bacterial inoculum (1 x 10^5 CFU per gram of fresh forage) + propionic acid (0.45 kg per ton of fodder)). Ensiled mass was then gently and firmly squeezed to expel

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air, the neck of the bag was twisted, turned over and tied with twine. Polythene bags containing chopped fodder were then inverted into another empty clean bag, which was also later closed and tied. The polythene bags were appropriately labelled, sealed and placed in a plastic bucket to ensure protection from vermin and were stored at room temperature.

2.2. Evaluation and selection of ensiled grass fodder

The ensiled materials were evaluated for their physical and chemical characteristics at 21st day of ensiling. A score card was devised for evaluating the physical and chemical characteristics of silages obtained from laboratory ensiling. Total score of silage was calculated by taking the sum of assigned scores.

2.3. Sensory and chemical characteristics of silage

Silage odour was measured using score card devised. The sweet aroma, pungent and putrid odours were assigned +1, -1, and -2 scores, respectively. Silage colour was evaluated using the colour scores table for silages developed by Tahuk *et al.* (2021). The natural green or yellowish green colour was given score of +2, dark green or yellowish colour was awarded +1 and brown to black colour was given score of -1, respectively. Presence or absence of extraneous material as fungus or worms were observed and evaluated using score card. The absence of extraneous material was given a +1 score and their presence was given a -1 score, respectively.

The pH and lactic acid (g/100g fresh silage) of silage was estimated by method described by Australian Fodder Industry Association Laboratory Methods Manual (2011) and the procedure given by Wilson and Wilkins (1972), using a spectrophotometer (Avi Scientific India, Thane, Mumbai), respectively. Data gathered on various parameters were analysed statistically (Snedecor and Cochran, 1994) using SPSS version 24.0.

3. Result and Discussion

3.1. Sensory characteristics of silage

The sensory characteristics of various silages at 21st day of ensiling are presented in Table 1. GS had an undesirable pungent odour with dark green colour on 21st day of ensiling. GSL produced a desirable sweet aroma on 21st day of ensiling with a yellowish green colour. GSA produced an undesirable pungent odour and dark green colour whereas GSLA had a sweet aroma at 21st day of ensiling. Presence of fungus or worms was not observed in any samples. Based on the results, GSL was found to have faster and better ensiling properties than other groups. Similar observations were made by Obrien *et al.* (2008), who noted that the excellent quality silages had fresh texture and should not contain any fungal organisms in it. In a similar study, Randa *et al.* (2018) observed a light yellow to greenish colour and moderately sweet aroma for good quality silage and this observation was similar to the present study. Habib *et al.* (2022) found that the colour of Napier grass silage as straw yellowish with a sweet fruity aroma and their observation was in well accordance with the present study.

Table 1 Sensory and chemical characteristics of silages at 21st day of ensiling

Sl. No		Silage characteristics	Score obtained for silages				
			GS	GSL	GSA	GSLA	*p*-value
1		pH	5.6	4.3	5.2	4.4	
	a	Less than 4.2 (+++)	0	0	0	0	
	b	4.2-4.5(++)	0	+2	0	+2	
	c	4.5-4.8(+)	0	0	0	0	
	d	More than 4.8 (-)	-1	0	-1	0	
2		Odour					
	a	Sweet Aroma (+)	0	+1	0	+1	
	b	Pungent (-)	-1	0	-1	0	
	c	Putrid (- -)	0	0	0	0	
3		Appearance (colour)					

	a	Natural green or yellowish green (++)	0	+2	0	0	
	b	Dark green or brownish green (+)	+1	0	+1	+1	
4		Presence or Absence of extraneous matter-Fungus or Worms (-/+)	+ 1	+ 1	+ 1	+ 1	
5		Lactic acid concentration (g/100g fresh silage)	$0.20^{d} \pm 0.001$	$5.47^{a} \pm 0.015$	$0.51^{c} \pm 0.002$	$4.07^{b} \pm 0.030$	<0.001**
		Total score	0	+6	0	5	

** Significantly different with in the row

3.2. Chemical characteristics of silage

The chemical characteristics of various silages at 21st day of ensiling are presented in Table 1. The pH value of GS, GSA, GSL and GSLA after 21 days of ensiling were found to 5.6, 4.3, 5.2 and 4.4, respectively. Similarly, Kung *et al.* (2018) reported that pH values of good quality silage ranged between 4.3 and 4.7. The lactic acid concentration reported were 0.20, 5.47, 0.51 and 4.07 for GS, GSA, GSL and GSLA, respectively. In agreement with the present studies, Boonkoed *et al*. (2018) reported that lactic acid concentration of Napier silage was 4.45 per cent of total volatile fatty acid. The lactic acid concentration was found to significantly increased in groups on addition of bacterial inoculum.

4. Conclusion

Based on the results of laboratory ensiling, it was found that the Hybrid Napier grass ensiled *with L. plantarum* as additive at the rate of 1 x 10^5 CFU per gram of fresh forage for 21 days resulted in the production of superior quality silage with acceptable acidic pH, greenish yellow colour, desirable aromatic smell, and higher lactic acid concentration. Based on the total score of various grass silages, it could be concluded that use of additives had improved the sensory attributes and chemical characteristics of silage. Hence GSL was selected to be the best quality silage after 21 days of ensiling. Further studies needs to be conducted to identify the best combinations of additives that supports production of good quality silages in minimal time period.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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