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Nutritive value and silage quality in fodder sorghum (*Sorghum bicolor*), maize (*Zea mays*) and hybrid napier (*Pennisetum americanum* × *P. purpureum*) grown in Sri Lanka

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Introduction

For continuous genetic improvement of cows, nutrition and management conditions should be improved to allow cow to produce its inherited potential production. However, many farmers not pay desired attention on forage quality and one of the main reasons for the low productivity of dairy cattle is under nutrition. Therefore, production of high quality fodder varieties is vital for strengthening the dairy sector in Sri Lanka. Hybrid Napier var. CO-3 is widely used for cattle feeding in Sri Lanka. It is important to find out other forage varieties with maximum nutritive values and minimum anti-nutritive factors which can be used as a cattle feed. Sorghum is a crop for semi-arid regions in tropical and sub-tropical zones which can be grown successfully throughout the country both under irrigated and rain-fed conditions. In addition, it has shown a huge potential to produce high green fodder yields. Maize is one of the most important plants grown for fodder production in the world. It possesses most of the characteristics of an ideal type of fodder and forage plant. Hence, this field research was conducted to investigate the possibilities in use of fodder Sorghum var. sugargraze and Maize var. pacific 984 as green fodder and/or silage in Sri Lanka.

Materials and Methods

The field experiment was conducted in a Randomized Complete Block Design (RCBD). Three blocks were arranged and three plots (6 m × 2.5 m) were maintained in each block. Fodder sorghum, hybrid napier and maize were randomly allocated in the plots. Harvests were obtained from all the plots at 50% flower initiation stage at a height of 10 - 12 cm from the soil surface and silage was prepared. Forage samples were analyzed for dry matter (DM) and crude protein (CP), according to AOAC (2005). Gross energy (GE) contents of samples were determined by bomb calorimeter. In addition, soluble carbohydrate (SC), nitrate and oxalate contents were analyzed following anthrone, spectrophotometer and permanganate methods, respectively. Spectrophotometer was used to analyze lactic acid contents and titratable acidity was measured using NaOH with titration. Data were statistically analyzed to determine the statistical significance among the treatments. Analysis of variance was carried with mixed procedure in Statistical Analytical Systems (SAS, 1996). The mean comparison of each parameter was done with Tukey's Studentized Range Test with 95% confidence interval.

Results and Discussion

Plant height, number of shoot, tillering capacity, leaf/stem ratio and yielding potential are some of the most important factors that influence the choice of variety to be grown, since they have a direct influence on total forage yield as tall forage cultivars yield more than short cultivars due to the strong positive relationship between plant height and yield (Assaeed, 1984). Plant height, fresh yield and dry matter yield were significantly higher ($P < 0.05$) in sorghum compared to hybrid napier (Table 1). Therefore, Sorghum can be popularized among Sri Lankan farmers as potential fodder variety to be selected for their cattle.

Crude protein and fiber contents of hybrid napier were significantly higher ($P < 0.05$) than maize but similar to sorghum. Even though hybrid napier is one of the widely cultivated hybrid fodders in Sri Lanka, sorghum would be an ideal substitution for hybrid napier when considered the crude protein contents. There were no differences ($P > 0.05$) in soluble carbohydrate contents among the three fodder varieties. There were no significant differences ($P > 0.05$) in SC, GE and DM contents among the varieties. But numerically, amount of gross energy in sorghum was higher than hybrid napier and maize.

Most forage contains some nitrate which is not particularly toxic to cattle but excess consumption can cause adverse effects. Also it has been shown that soluble oxalate have adverse effects on cattle (Rahman *et al.*, 2011). Therefore, when selecting fodder varieties we have to pay attention not only on the nutrients, anti-nutrient factors as well. There was a

significant difference ($P < 0.05$) in nitrate contents between hybrid napier and sorghum. However, nitrate levels of three fodder varieties were below the toxic level (1.76% DM basis). Even though it was lower than toxic level (2% or more in DM basis) (Rahman *et al.*, 2011). Soluble oxalate contents were significantly higher ($P < 0.05$) in hybrid napier compared to maize and sorghum.

Ensiling a method for the preservation of wet forage crops, is based on a spontaneous lactic acid fermentation under anaerobic conditions, where lactic acid bacteria convert water soluble carbohydrates in the crop to lactic acid and to lesser extend to the acetic acid. The conservation is caused by the pH drop of ensiled material due to organic acid formation which inhibits the growth spoilage microorganisms in silage. Silage should have pH range between 3.8-4.2 to be in good quality and pH of all silage was laid below the level of 4.7. Further, pH value of silage prepared from sorghum was significantly lower ($P < 0.05$) compared to hybrid napier and maize. Having higher percentage (>3%) of lactic acid is a good indicator of quality silage and the lactic acid contents of three fodder varieties were more than 4%. Titratable acidity of silage made with sorghum was significantly higher ($P < 0.05$) than hybrid napier and maize.

Table 1. Yield parameters, nutritive qualities, anti-nutritional factors and silage qualities of fodder sorghum, hybrid napier and maize

Variables	Fodder		
	Hybrid Napier	Maize	Sorghum
Yield parameters			
Plant height, cm	151.7 ± 7.6 ^a	155.3 ± 7.6 ^{ab}	191.1 ± 7.6 ^b
Fresh yield, t/ha	15.1 ± 1.7 ^a	22.7 ± 1.7 ^a	32.0 ± 1.7 ^b
Dry matter yield, t/ha	4.0 ± 0.4 ^a	5.0 ± 0.4 ^{ab}	7.0 ± 0.4 ^b
Nutritive value			
Crude Protein, %DM	13.3 ± 0.8 ^a	8.7 ± 0.8 ^b	11.6 ± 0.8 ^{ab}
Crude Fiber, %DM	37.8 ± 0.4 ^a	34.7 ± 0.4 ^b	36.8 ± 0.4 ^{ab}
Soluble Carbohydrates, %DM	2.6 ± 0.1	2.6 ± 0.1	2.8 ± 0.1
Gross Energy, KJ kg/DM	11286 ± 541	11648 ± 541	11927 ± 541
Dry Matter, %	24.1 ± 0.4	23.3 ± 0.4	22.1 ± 0.4
Anti-nutritional factors			
Nitrate, %DM	0.002 ± 0.001 ^a	0.005 ± 0.001 ^{ab}	0.007 ± 0.001 ^b
Soluble Oxalate, %DM	0.67 ± 0.04 ^a	0.42 ± 0.04 ^b	0.45 ± 0.04 ^b
Silage quality			
pH	4.77 ± 0.06 ^a	4.54 ± 0.05 ^a	3.59 ± 0.05 ^b
Lactic acid, %	5.18 ± 0.46	4.17 ± 0.46	5.90 ± 0.46
Titratable acidity, %	15.60 ± 0.62 ^a	12.90 ± 0.62 ^a	21.60 ± 0.62 ^b

Data are presented as mean ± SD

^{a, b} Means within the same row with different superscripts are significantly different ($p < 0.05$)

Conclusion

In conclusion, yield parameters of sorghum were better than maize and hybrid napier when it is fed as fresh forage. Many nutritive qualities of sorghum were similar to hybrid napier and anti-nutritional factors were lower compared to hybrid napier. Sorghum silage quality was better than maize and hybrid napier silage. Therefore, sorghum *var. sugargraze*; in fresh form or silage could be effectively utilized to increase nutrition status of dairy cows in Sri Lanka.

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