ORIGINAL RESEARCH

Comparison of Yield, Nutritive Value and Silage Quality of Fodder Sorghum (*Sorghum bicolor*) and Maize (*Zea mays*) with Hybrid Napier Variety CO-3

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Abstract

Popularization of high quality fodder among dairy farmers is vital for strengthening the dairy sector in Sri Lanka. Therefore, present study was carried out to compare the yield, nutritive value and silage quality of recently introduced fodder species; Sorghum var. sugargrazea and Maize var. pacific 984 with hybrid Napier var. CO-3 which is the commonly used fodder species by the dairy farmers. Field experiment was conducted as a Complete randomized block design (CRBD). Harvests were obtained at 50% flowering stage and silage was prepared. Yield and nutritive parameters, anti-nutritive factors and silage quality parameters were analyzed. Plant fresh and dry matter (DM) yields and plant height were significantly greater ($p<0.05$) in Sorghum compared to hybrid Napier var. CO-3. Crude protein content was significantly lower ($p<0.05$) in Maize compared to hybrid Napier var. CO-3, but it was similar in hybrid Napier var. CO-3 and Sorghum. Oxalate contents were significantly lower ($p<0.05$) in Sorghum and Maize compared to hybrid Napier var. CO-3. The lowest pH and highest titratable acidity were recorded in Sorghum silage. Therefore, it can be concluded that Sorghum var. sugargraze and Maize var. pacific 984; in fresh form or silage are potential feed resource to be effectively utilized in feeding dairy cows in Sri Lanka.

Keywords: Hybrid Napier var. CO-3, Maize, Nutritive qualities, Silage, Sorghum

Introduction

Genetic potential, feeding program, cow herd management and animal health are the key main influencing factors on the milk yield. When cows continue to improve genetically, nutrition and management conditions should be improved to allow cow to produce its inherited potential production. Therefore, good feeding programs should be practiced. The amount of milk produced is highly influenced by the availability and efficient utilization of feed resources. With relatively low disease challengers, Sri Lankan dairy farmers can obtain maximum production with upgraded dairy cattle paying attention to feeding programs under good management systems[1].

Combination of good quality forage, concentrates and crop residues can be efficiently utilized as the basal feed for sustaining and increasing Sri Lanka's dairy production[2]. As

in many dairy milk producing countries in the region, the cheapest source of animal feed is forage in Sri Lanka[3]. Sri Lankan dairy farmers mainly use Guinea grass (*Panicum maximum*) and hybrid Napier var. CO-3 (*Pennisetum americanum* × *Pennisetum purpureum*) as feed sources. Hybrid Napier var. CO-3 has been accepted as one of the high yielding fodder crops in Sri Lanka[4]. Other than that, Sorghum and Maize are recently introduced fodder species among dairy farmers. Sorghum is a crop for semi-arid regions in tropical and sub-tropical zones where moisture is a limiting factor for crop growth. It can be grown successfully throughout the country both under irrigated and rain-fed conditions. To increase the fodder production, new high yielding varieties of Sorghum has been developed and Sugargraze is a top quality 3-way cross among Sorghum, Sorgho and Sudan-grass[5]. Maize is one of the most important plants grown for fodder production in the world and it possesses most of the characteristics of an ideal type of fodder[6].

However, yield parameters, nutritive quality parameters and adverse factors are different from forage to forage. Adverse factors such as oxalate, nitrates and cyanides etc. which can greatly affect the animal's health and performances. Feeding forages containing levels of 2.0% or more soluble oxalate in dry matter basis can lead to acute toxicities in ruminants[7] and plants containing more than 1.76% nitrate affects badly on animals' health[8]. Hence, it is important to find out the nutritive and anti-nutritive factors of Sorghum and Maize which may have a greater potential to popularize as a fodder crops among Sri Lankan dairy farmers. Therefore, present study was carried out to compare the yield, nutritive value and silage quality of fodder Sorghum var. sugargraze and Maize var. pacific 984 with hybrid Napier var. CO-3 grown under local conditions.

Materials and Methods

Experimental Design and Sample Collection

The experiment was conducted as a Complete Randomized Block Design (CRBD) at Animal Experimental Farm, Veterinary Research Institute, Gannoruwa, Sri Lanka. Land was divided into three blocks and three plots (plot size = 6 m × 2.5 m) were maintained in each block. Randomization was done within each block separately and the fodder varieties were randomly allocated in the plots. The harvests were obtained from all the plots at 50% flower initiation after establishment (at a height of 10 - 12 cm from the soil surface).

Samples and Silage Preparation

Harvested forage samples were cut into small pieces. Portion was filled into silage bags which were kept for 45 days for final analysis before drying. Other portion, was dried at 80°C until it reached to a constant weight. Dried samples were ground into powder form and stored in labeled glass bottles for laboratory analysis.

Laboratory Analysis of Forage Samples

Forage samples were analyzed for dry matter (DM) and crude protein (CP), according to AOAC procedures[9]. Gross energy contents of samples were determined by bomb calorimeter. In addition, soluble carbohydrate, nitrate and oxalate contents were analyzed using anthrone method[10], Colorimetric method[11] and permanganate method[12] respectively. Moreover, pH values of silage samples were determined by a pH meter.

Spectrophotometer was used to analyze lactic acid contents and titratable acidity was measured titrating with NaOH.

Statistical Analysis

Observed data were analyzed using two-way Analysis of Variance (ANOVA) procedure of Statistical Software for Data Analysis ver. 9.0[13]. Mean separation was done by Dunnett's test and statistical significance was declared at $p < 0.05$. The experimental model applied was:

$Y_{ij} = \mu + T_i + B_j + E_{ijk}$

Where:

Y_{ij} = Any observation made in the experiment

M = Observed mean

T_i = Effect of treatment (i = Sorghum, Maize and CO3)

B_j = Block effect

E_{ijk} = Residual error

Results and Discussion

Growth, Fresh Yield and Dry Matter Yield of Fodder Sorghum and Maize

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[14]. Result revealed that, forage height was significantly greater in Sorghum compared to hybrid Napier var. CO-3 ($p < 0.05$, Table 1). As expected, greater ($p < 0.05$) fresh and dry matter yields were recorded in Sorghum compared to hybrid Napier var. CO-3 confirming the findings of Assaeed[14], as tall forage cultivars yield more than short cultivars due to the strong positive relationship between plant height and yield. Further, Bishnoi *et al*[15] reported the same trend by comparing DM yields of Sorghum with pearl millet and he stated that Sorghum produced significantly more DM than that of other crops. There were no differences ($p > 0.05$) in plant height and dry matter yields between hybrid Napier var. CO-3 and Maize though, reported fresh yield of Maize was significantly greater ($p < 0.05$) compared to fresh yield of hybrid Napier var. CO-3.

Nutritive Qualities of Fodder Sorghum and Maize

Crude protein and fiber contents of hybrid Napier var. CO-3 were significantly higher ($p < 0.05$) than Maize however, there were no significant differences ($p > 0.05$) in crude protein and fiber contents between hybrid Napier var. CO-3 and Sorghum (Table 1). Even though CO-3 is one of the widely cultivated hybrid fodders in Sri Lanka, Sorghum would be an ideal substitution for hybrid Napier var. CO-3 when considered the crude protein and fiber contents. There were no significant differences ($p > 0.05$) in soluble carbohydrate, gross energy and dry matter contents of Maize and Sorghum compared to hybrid Napier var. CO-3. However numerically, amount of soluble carbohydrates and gross energy in Sorghum was higher than hybrid Napier var. CO-3.

Table 1. Yield parameters, nutritive qualities, adverse factors and silage qualities of fodder Sorghum, hybrid Napier and Maize

Variable	Fodder			SEM
	CO-3	Maize	Sorghum	
Yield parameters				
Plant height, cm	151.7[a]	155.3[a]	191.1[b]	8.2
Fresh yield, t/ha	15.1[a]	22.7[b]	32.0[b]	1.8
Dry matter yield, t/ha	3.6[a]	5.3[a]	7.1[b]	0.5
Nutritive qualities				
Crude Protein, %DM	13.3[a]	8.7[b]	11.6[a]	0.6
Crude Fiber, %DM	37.8[a]	34.7[b]	36.8[a]	0.4
Soluble Carbohydrates, %DM	2.6	2.6	2.8	0.1
Gross Energy, KJ kg/DM	11286	11648	11927	541
Dry Matter, %	24.1	23.3	22.1	0.4
Adverse factors				
Nitrate, %DM	0.002[a]	0.005[b]	0.007[b]	0.001
Soluble Oxalate, %DM	0.67[a]	0.42[b]	0.45[b]	0.04
Silage quality				
pH	4.77[a]	4.54[b]	3.59[b]	0.05
Lactic acid, %	5.18	4.17	5.91	0.40
Titratable acidity, %	15.60[a]	12.90[a]	21.60[b]	1.26

[a, b] Means within the same row with different superscripts are significantly different ($p < 0.05$)
*SEM - Standard Error of means

Anti-nutritive Factors of Fodder Sorghum and Maize

Most forage contains some nitrates though it is not particularly toxic to cattle but excess consumption can cause adverse effects[8]. Also soluble oxalate is a anti-nutritive factor and excess amounts can adversely affect on ruminants[16,17] . Nitrate contents were significantly different ($p > 0.05$) when hybrid Napier var. CO-3 was compared with Sorghum or Maize (Table 1). However, nitrate levels of three fodder varieties were retained below the toxic level (1.76% DM)[18]. Therefore, these fodder varieties are safer to feed dairy animals. Even though it was lower than toxic level (20 g/kg (2%) or more in DM basis)[16], soluble oxalate contents were significantly higher ($p < 0.05$) in hybrid Napier var. CO-3 compared to Maize and Sorghum. Therefore, plants having a higher tendency to accumulate soluble oxalate such as hybrid Napier var. CO-3 might not be selected for cultivation or have to feed restricted amounts since feeding forages with higher oxalate create adverse effects on the animal. Otherwise, consumption of oxalate containing plants by ruminants should be carefully monitored.

Silage Qualities of Fodder Sorghum and Maize

Ensiling is a method used for the preservation of wet forage crops. It is based on a spontaneous lactic acid fermentation under anaerobic conditions, whereby lactic acid bacteria convert water soluble carbohydrates in the crop to lactic acid and to lesser extend to the acetic acid[19]. The conservation is caused by the pH drop of ensiled material due to organic acid formation which inhibits the growth of spoilage microorganisms in silage. A

good silage make from tropical forages has a pH less than 5.0, the percent of total nitrogen which is ammonia (NH_3N:N) of less than 15%, lactic acid which is 50% or more of the total organic acids and butyric acid content of not greater than 0.5% of the total dry matter[20].

Silage should have pH range between 3.8 - 4.2 to be in good quality [21] and pH value of silage prepared from Sorghum and Maize were significantly lower *($p < 0.05$)* compared to hybrid Napier var. CO-3. Sorghum silage staying to be accepted as good quality silage as the pH of it was about 4.0 (Table 1). Lactic acid, acetic acid and propionic acid are major acids which make silage acidity. Having higher percentage (>3%) of lactic acid is a good indicator of quality silage[21]. Titra table acidity of silage made with Sorghum was significantly higher *($p < 0.05$)* than hybrid Napier var. CO-3 though there were no significant differences between hybrid Napier var. CO-3 and Maize.

Conclusion

Yield parameters of Sorghum are better than hybrid Napier var. CO-3 when it is fed as fresh forage. Many nutritive qualities of Sorghum are similar to hybrid Napier var. CO-3 and adverse factors are lower compared to hybrid Napier var. CO-3. When Sorghum is preserved as silage, the qualities are better than silage prepared from hybrid Napier var. CO-3. Further, some yield parameters and nutritive attributes are better in Maize compared to hybrid Napier var. CO-3. Therefore, Sorghum var. sugargraze and Maize var. pacific 984; in fresh form or silage are potential feed resource to be effectively utilized in feeding dairy cows in Sri Lanka.

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