

Bromatological analysis of millet cv. Ceará (*Pennisetum glaucum*) irrigated with treated gray water dilutions in well water

Abstract

The present work aimed to analyze the viability of gray water use on bromatological quality of millet cv. Ceará (*Pennisetum glaucum*). The experiment was carried out in the greenhouse, on the department of agronomic and forestry sciences at the Federal Rural University of the Semi-Arid – UFERSA, Mossoró, RN, Brazil. The experimental design used was randomized blocks with five treatments and six replications, totaling thirty plots. The experiment was carried out in vases with the volume of 25 L containing four plants per vase. The treatments consisted in five dilutions of TGW in WW: T1 – 100% WW plus 0% TGW; T2 – 75% WW plus 25% TGW; T3 – 50% WW plus 50% TGW; T4 – 25% WW plus 75% TGW and T5 – 0% WW plus 100% TGW. It was analyzed dry matter, ashes, fibers in neutral and acid detergents, nitrogen and protein indigestible in acid detergent and crude protein. From the presented results, it can be concluded that the dilution that promoted better bromatological quality was treatment T3 with 50% of treated gray water plus 50% of well water, however, forage production irrigated only with treated gray water shown to be used in semiarid regions.

Keywords: *Pennisetum glaucum*, sustainability, forage

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Introduction

Only a small perceptual of all planet's water presents as fresh and available to population's use. Water of quality is becoming scarcer with environmental pollution and its use is getting restricted to supply human needs.¹ The semiarid region is characterized for having variations in rainfall with long periods of drought and only few months with rain throughout the year, high evapotranspiration rate and poor and shallow soils.² Many animals raised by small farmers are fed in extensive regime, which the animals must search their own food, or semi-intensive, which they spend part of their time in pasture and the other part of the food is provided by the farmer. However, vegetation of semiarid regions presents low capacity to supply animals demand during dry season, besides it is difficult to produce a pasture of quality with water scarcity and with poor soils.³

The Millet (*Pennisetum glaucum*) is a good alternative for animals feeding in these regions, it is a rustic culture with low demand for inputs when compared to other forages, it produces silage of good nutritional quality, establishes easily and is has good palatability. The use of wastewater on irrigation shows to be promising.⁴ Some research has shown that, *Brachiaria brizantha* cv. Mandaru presented rise in dry matter and crude protein contents and reduction in fiber in neutral and acid nutrients, and also obtained higher content of crude protein in Tifton and black oat irrigated with cattle wastewater than with mineral fertilization.^{5,6} The gray water is a domestic wastewater from sinks, showers, washing machines, etc. except from toilets. Its use projection on irrigation can be viable since it presents low fecal contamination than other wastewaters and it is produced in great amount on residences. Thus, this work aimed to analyze viability of gray water's use to analyse its effect on bromatological quality of millet forage.

Methods

The experiment was carried out on greenhouse, on the department

of agronomic and forestry sciences at the Federal Rural University of the Semi-Arid – UFERSA, Mossoró, RN, Brazil (05°12'03.9" S; 37°19'98" W). according to koppen's climate classification, the region's climate is classified as BSh, which is a country climate, semiarid, warm and dry, with low altitude and latitude, morphoclimatic domain caatinga, average annual rainfall lower than 650mm and average annual temperature higher than 265°C.⁷ In this region the average annual rainfall is 673.9 mm, humidity of 65.9% and average speed of wind is 3.32ms⁻¹.^{8,9} The experimental design used was randomizes blocks with five treatments and six replications, totaling thirty plots. The experiment was carried out in vases with volume of 25L containing four plants per vase. The treatments consisted in five dilutions of TGW in WW: T1 – 100% WW plus 0% TGW; T2 – 75% WW plus 25% TGW; T3 – 50% WW plus 50% TGW; T4 – 25% WW plus 75% TGW and T5 – 0% WW plus 100% TGW. Gray water dilutions are recommended to reduce salt concentration and to identify the most adequate dilution to culture development.^{8,10} As substrate, it was used soil classified as Typic Rhodustults, collected from the experimental farm Rafael Fernandes, Mossoro, RN, whose chemical characteristics are presented on Table 1.¹¹

The gray water was collected from a treatment station located on Monte Alegre I settlement (5°3'13.06" S; 37°27'23.27" W) in Upanema, RN. The gray water produced in the residence is composed by shower, bathroom sink and laundry tanks. The house is inhabited by two people and they have three visitors on weekends, producing average of 80L of gray water per day. The applications of gray water dilutions in well water was carried out through an irrigation system of microtubes with a PVC reservoir (60L), an circulating pump Metalcorte/Eberle, self-ventilated, EBD250076 model, lateral lines of 16mm and microtubes with average flow of 8.5L h⁻¹. The irrigation system applied, daily, the needed volume of dilutions to increase soil humidity until its maximum water retention capacity. The climatic data were collected inside the greenhouse during the experimental period, minimum (MinTem), medium (MedTem) and maximum (MaxTem)

temperatures, minimum (MinRH), medium (MedRH) and maximum (MaxRH) relative humidity and global radiation. Temperatures varied from 26.8 to 29.1°C; 27.6 to 29.8°C; 28.3 to 30.6°C, to minimum, medium and maximum, respectively (Figure 1A). For relative

humidity, the variations were from 38.9 to 57.8% for MinRH, 41.8 to 60.3% for MedRH and 44.7 to 62.9% for MaxRH (Figure 1B). Solar radiation inside the greenhouse varied from 14.9 to 26.7 MJ m⁻² with average of 20.2 MJ m⁻² (Figure 1C) (Table 2).

Table 1 Chemical characteristic of soil before irrigation with treated gray water dilutions in well water

Depth (cm)	pH (water)	EC dSm ⁻¹	OM mg dm ⁻³	P mg dm ⁻³	K ⁺ mg dm ⁻³	Na ⁺ mg dm ⁻³	Ca ²⁺ mg dm ⁻³	Mg ²⁺ mg dm ⁻³	Al ³⁺ mg dm ⁻³	H+Al mg dm ⁻³	SB mg dm ⁻³	T mg dm ⁻³	CEC cmol _c dm ⁻³	V %	ESP %
0 - 20	6.10	0.41	3.31	1.90	26.90	4.70	1.10	0.70	0.00	1.49	1.89	1.89	3.37	56	1
20-40	4.80	0.03	2.07	1.70	26.90	4.70	0.40	1.00	0.15	1.98	1.49	1.64	3.47	43	1

Note: pH, Hydrogen potential; EC, electrical conductivity; OM, organic matter; P, phosphorus; K, potassium; Na⁺, sodium; Ca²⁺, calcium; Mg²⁺, Magnesium; Al³⁺, Aluminium; (H+AL), potential acidity; SB, Sum of bases; CEC, cation; ESP, Exchange capacity; V, Base saturation; ESP, exchangeable sodium percentage.

Table 2 Physico-chemical characteristics of treated gray water (TGW) and well water (WW) and its related average (A) and standard deviation (SD)

	08/21/2017		09/21/2017		10/16/2017		WW	TGW
	WW	TGW	WW	TGW	WW	TGW	A±SD	A±SD
Al (mg L ⁻¹)	0.213	0.125	0.084	0.099	0.053	0.133	0.117±0.085	0.119±0.018
As (mg L ⁻¹)	0	0	0.000	0.000	0.000	0.000	0±0	0.000±0.000
B (mg L ⁻¹)	0.512	0.366	0.415	0.244	0.350	0.412	0.426±0.082	0.341±0.087
Ba (mg L ⁻¹)	1.841	1.948	2.632	2.281	2.323	1.868	2.265±0.399	2.032±0.219
Cr (mg L ⁻¹)	0.064	0.105	0.012	0.000	0.013	0.004	0.030±0.030	0.036±0.060
Cu (mg L ⁻¹)	0.006	0.039	0.088	0.08	0.088	0.088	0.061±0.047	0.069±0.026
Mn (mg L ⁻¹)	0.029	0.377	0.062	0.177	0.061	0.124	0.051±0.019	0.226±0.133
Fe (mg L ⁻¹)	0.03	1.404	0.087	0.498	0.094	0.471	0.070±0.035	0.791±0.531
Ni (mg L ⁻¹)	0.081	0.053	0.012	0.000	0.015	0.028	0.036±0.039	0.027±0.027
Cd (mg L ⁻¹)	0	0	0.018	0.006	0.020	0.025	0.013±0.011	0.010±0.013
Pb (mg L ⁻¹)	0.06	0.049	0.002	0.043	0.001	0.04	0.021±0.034	0.044±0.005
Zn (mg L ⁻¹)	0.018	0.291	0.031	0.076	0.034	0.076	0.028±0.009	0.148±0.124
pH	7.1	7.5	7.12	7.59	7.05	7.97	7.090±0.030	7.693±0.242
EC (dS m ⁻¹)	0.5	1.4	0.42	1.33	0.52	1.70	0.467±0.050	1.477±0.197
K ⁺ (mmol _c L ⁻¹)	0.2	1.3	0.21	1.08	0.20	1.34	0.209±0.008	1.246±0.144
Na ⁺ (mmol _c L ⁻¹)	5.4	8.2	3.75	6.22	3.50	10.89	4.202±1.008	8.431±2.345
Ca ²⁺ (mmol _c L ⁻¹)	0.5	3.3	0.55	4.8	0.67	1.84	0.586±0.073	3.280±1.455
Mg ²⁺ (mmol _c L ⁻¹)	0.3	2.1	0.20	0.86	0.43	4.98	0.322±0.116	2.638±2.117
Cl ⁻ (mmol _c L ⁻¹)	2.9	8.5	1.20	5.40	2.00	6.40	2.022±0.834	6.778±1.600
CO ₃ ²⁻ (mmol _c L ⁻¹)	0.0	0.0	0.20	0.40	0.20	0.50	0.133±0.115	0.300±0.265
HCO ₃ ⁻ (mmol _c L ⁻¹)	2.6	7.8	1.30	2.60	2.50	7.50	2.144±0.734	5.967±2.919
N (mg L ⁻¹)	-	-	-	40.43	-	34.56	-	37.49±2.940
P (mg L ⁻¹)	-	-	-	4.74	-	2.54	-	3.640±1.100

Table 3 Volume in liters of treated gray water (TGW) dilutions in well water (WW) and applied during the experimental period

Treatments	1-20 DAS		21-40 DAS		41-65 DAS		Accumulated		Total
	WW	TGW	WW	TGW	WW	TGW	WW	TGW	
Liters per vase									
T1	71.30	0.00	30.80	0.00	57.30	0.00	159.40	0.00	159.40
T2	71.30	0.00	23.10	7.70	43.00	14.30	137.40	22.00	159.40
T3	71.30	0.00	15.40	15.40	28.65	28.65	115.45	44.05	159.40
T4	71.30	0.00	7.70	23.10	14.30	43.00	93.30	66.10	159.40
T5	71.30	0.00	0.00	30.80	0.00	57.30	71.30	88.10	159.40

Note: DAS, Days after sowing; T1, 100% WW plus 0% TGW; T2, 75% WW plus 25% TGW; T3, 50% WW plus 50% TGW; T4, 25% WW plus 75% TGW and T5, 0% WW plus 100% TGW.

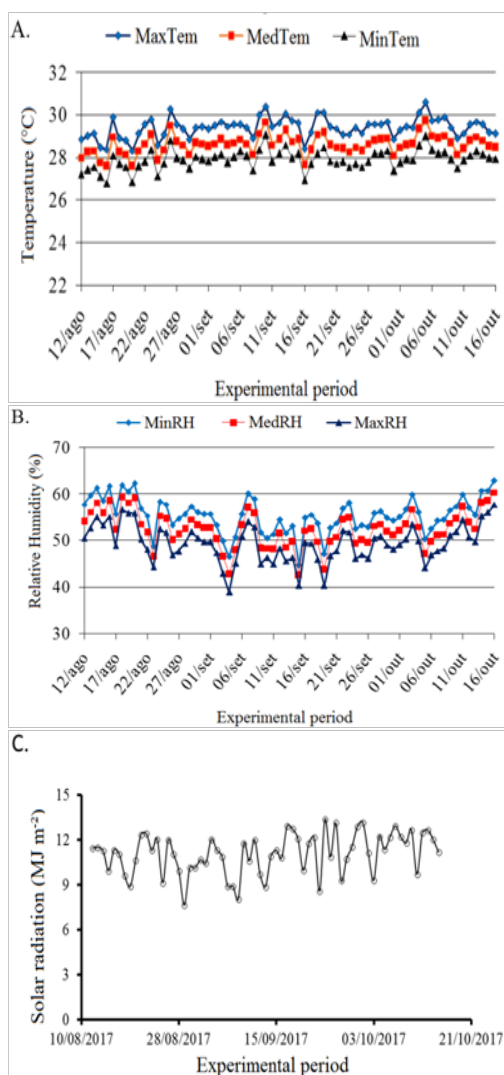


Figure 1 Climate data (A) Temperature; (B) Air relative humidity; (C) Solar radiation; obtained during the experimental period.

On Table 3 it is presented the volume of water applied during the experiment, showing that it was applied a total volume of 159.4L per vase in the end of the experiment for all treatments. Considering that treatments T4 and T5 received higher volumes of treated gray water, there was economy of 75 and 100% of well water for forage production, higher than forage production of treatment T1, that only used well water. The materials were collected manually on October 16th of 2017, 65 days after sowing. Plants were cutted 0.05m above the soil taking all its leaves and putted in paper bags. The material was weighted fresh to determine fresh matter and later sent to hothouse with forced air circulation on 65°C until it gets to constant weight to obtain dry matter. Then, the material was milled in Willey Mill and kept in plastic bags to go to laboratory analysis. On bromatology lab, the material went through analyses of neutral and acid detergent fiber (NDF and ADF), nitrogen and protein indigestible in acid detergent (NIDA and PIDA), and dry matter content, ashes and crude protein.^{3,12} The millet data of development and production were submitted to analysis of variance, using test F with 5% of probability. The means were compared though tukey test with 5% of probability. Regression models were chosen based on determination coefficient values and

regression equation coefficients, using test F with 5% of probability. Statistical analysis of data was carried out with aid of SISVAR programa.¹³

Results

The analyzes show that with exception of neutral and acid detergent fibers, the other variables were influenced by the treatments with significant differences of 5% and 1% (Table 4). The contents of dry matter and ashes presented reductions of 12.1% and 37.1%, respectively, when increased gray water concentration on dilutions (Figure 2A) & (Figure 2B). The content of NIDA and crude protein presented parabolic behavior, with initial reduction of its contents with increase in gray water's concentration in dilutions, and later increase. Its highest contents were obtained on treatments T1, 48% superior to the lower content, and T5, 56% superior to the lower content (Figure 2C), (Figure 2D), (Figure 2E), (Figure 2F) & (Figure 2G). The content of PIDA presented rose with increase in gray water dose, being 263% superior to treatments T1, only with well water (Figure 2F).

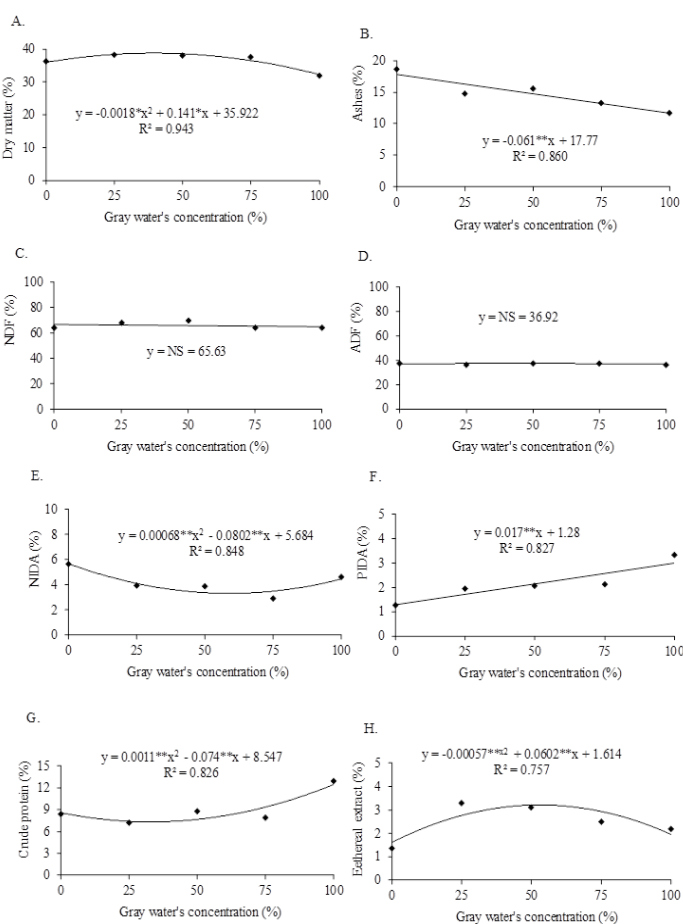


Figure 2 Dry matter (A) Ashes; (B) Neutral detergent fiber; (C) Acid detergent fiber; (D) Nitrogen indigestible in acid detergent; (E) Protein indigestible in acid detergent; (F) and crude protein; (G) of millet produced with treated gray water dilutions in well water.

Table 4 Summary of variance analysis of dry matter (DM), ashes (A), neutral detergent fiber (NDF), acid detergent fiber (ADF), nitrogen indigestible in acid detergent (NIDA), protein indigestible in acid detergent (PIDA) and crude protein (CP) of millet produced with treated gray water dilutions in well water

Variation sources	DF	Mean square						
		DM	A	NDF	ADF	NIDA	PIDA	CP
Gray water	4	41.80*	47.73**	43.07 ^{ns}	2.01 ^{ns}	6.12**	3.37*	30.00**
Blocks	5	46.08*	1.26 ^{ns}	7.25 ^{ns}	1.29 ^{ns}	0.83 ^{ns}	0.27 ^{ns}	4.79 ^{ns}
Error	20	13.51	4.27	20.98	5.03	0.90	0.82	2.57
CV (%)		10.13	13.59	6.98	6.08	22.50	42.31	17.67

Note: *, ** significant to 5% and 1% of probability, respectively, by F test. Ns non-significant by F test.

Discussion

The increase in treated gray water dose promoted rise in millet's crude protein, with structural importance on animals, as well as for its maintenance, growth and production., however, when in excess, protein is lost as urea. There was also an increase in PIDA and NIDA contents, which is the fiber not available for the animal, and reduction on dry matter and ashes. Similarly, the authors obtained higher crude protein content and reduction on neutral detergent fiber (FDN), with no significant difference on FDA and dry matter contents on Tifton 85 submitted to different doses of nitrogen. And other found different results with increase in dry matter of sorghum irrigated with domestic wastewater.^{10,14} Using wastewater from different origins, the author found reduction on dry matter content and rise in crude protein and neutral and acid detergent fibers on *Brachiaria brizantha* and other found increase on crude protein with no significant difference on dry matter content compared to mineral fertilization.^{5,6}

Conclusion

It can be said that gray water implementation was benefic to bromatological quality of the forage, since the best result can be found on dilutions. The dilution of 50% of treated gray water plus 50% of well water presented medium contents of crude protein, important to gain of weight, dry matter, ashes, NIDA and PIDA. It can be concluded that gray water is viable to millet's forage production in semiarid regions.

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Conflict of interest

Authors declare that there is no conflict of interest.

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