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UCDB

Fertilizer effect of UASB (55ºC) effluent with limestone as fixed bed treating vinasse on development of *Brachiaria Brizantha* cv. Xaraés

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Introduction

- Vinasse -> wastewater from alcohol and sugar industry;
- Latin America and Caribbean, Brazil -> agroindustry;
- Agroindustry -> organic wastes/organic matter;
- COD -> 60 – 100 $g.L^{-1}$ (Wilkie et al., 2000; López et al., 2010; Del Toro, 2001; Pérez y Garrido, 2008);
- 1 L alcohol -> 10 – 15 L of vinasse;
- pH -> 4,0 – 5,0 (Del Toro, 2001);
- Temperature -> 90°C;
- Pontential fertilizer (nitrogen, phosphorus, potassium).

Ponds / Storage

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Soil application / pumping / vehicle

Soil application / pumping / irrigation system

Soil application / vehicle

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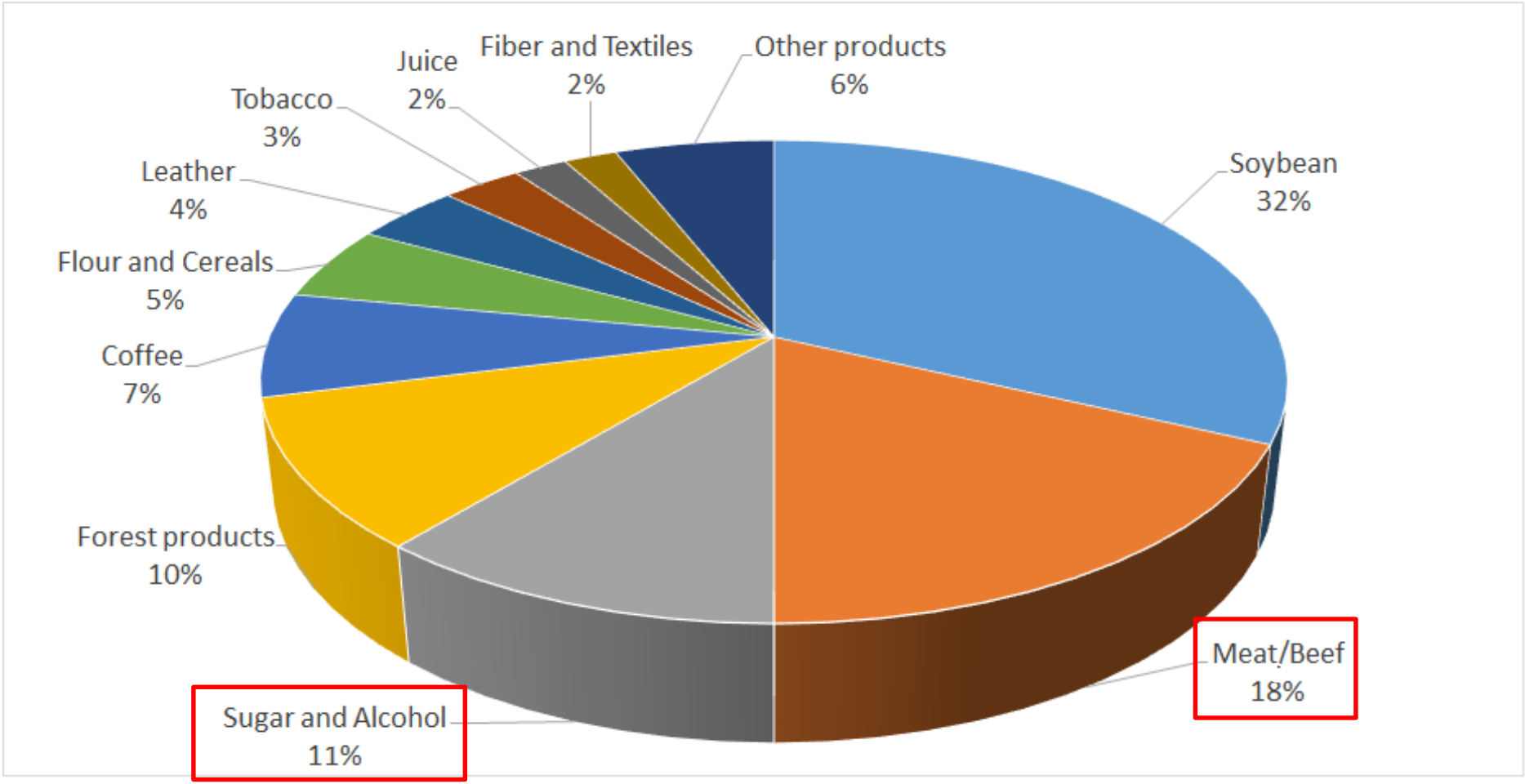
Agro-industry in Brazil



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Brachiria brizantha cv. xaraés

Objective

The objective was evaluated a **initial operation** of a **thermophilic (55 ºC) UASB** treating ***vinasse*** using ***fixed bed with limestone*** as a buffer agent *to avoid rapidly acidifying* and the ***effect of applying the irrigation effluent*** on *Brachiaria Brizantha cv. Xaraés*.

Materials and Methods

- Two lab-scale UASB reactors;
- PVC cylinder;
- 1 m high and 20 cm diameter;
- 27 L;
- 50% with limestone;
- Inside of a metallic drum (120 L);
- Oil to be heater at 55^{o}C

Two lab-scale UASB reactors

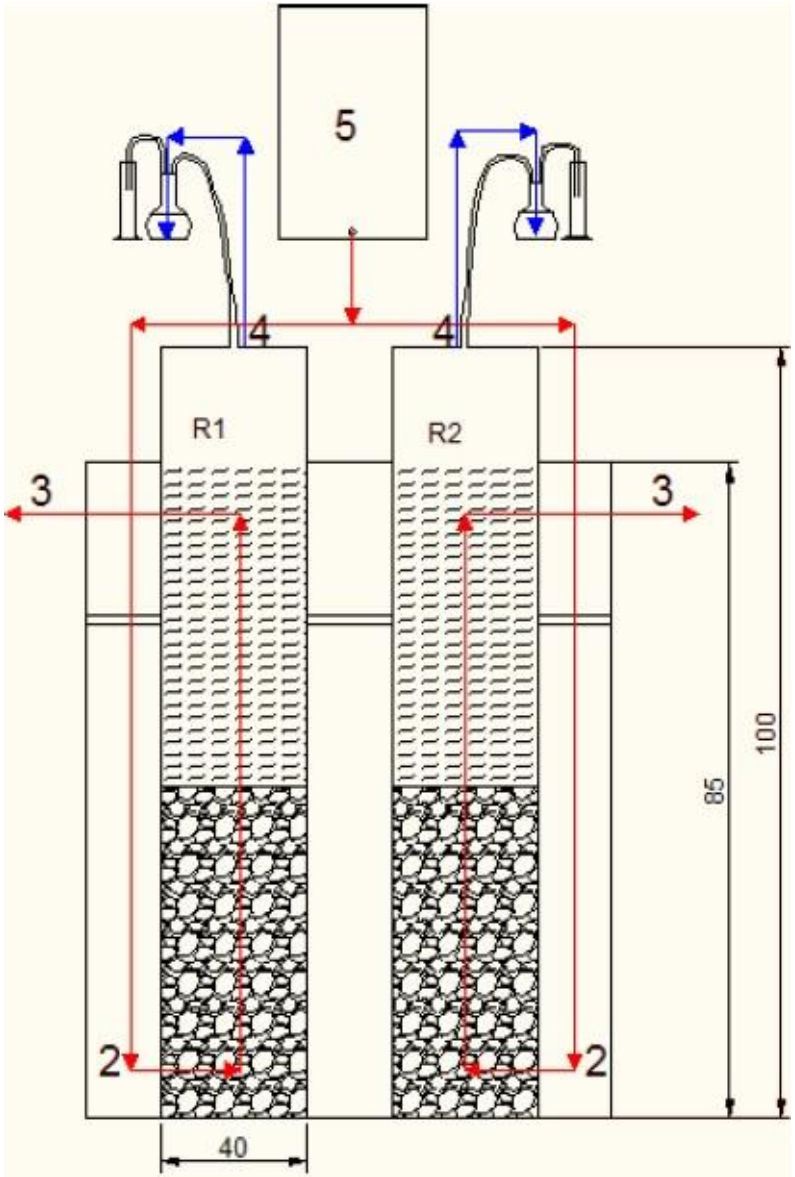

Figure 1. Experimental set-up:

(1) heater;
(2) inlet;
(3) effluent output;
(4) biogas output;
(5) equalization tank.
(6) Red line: vinasse;
(7) Blue line: Biogas.

(8) Dimensions in millimetres.

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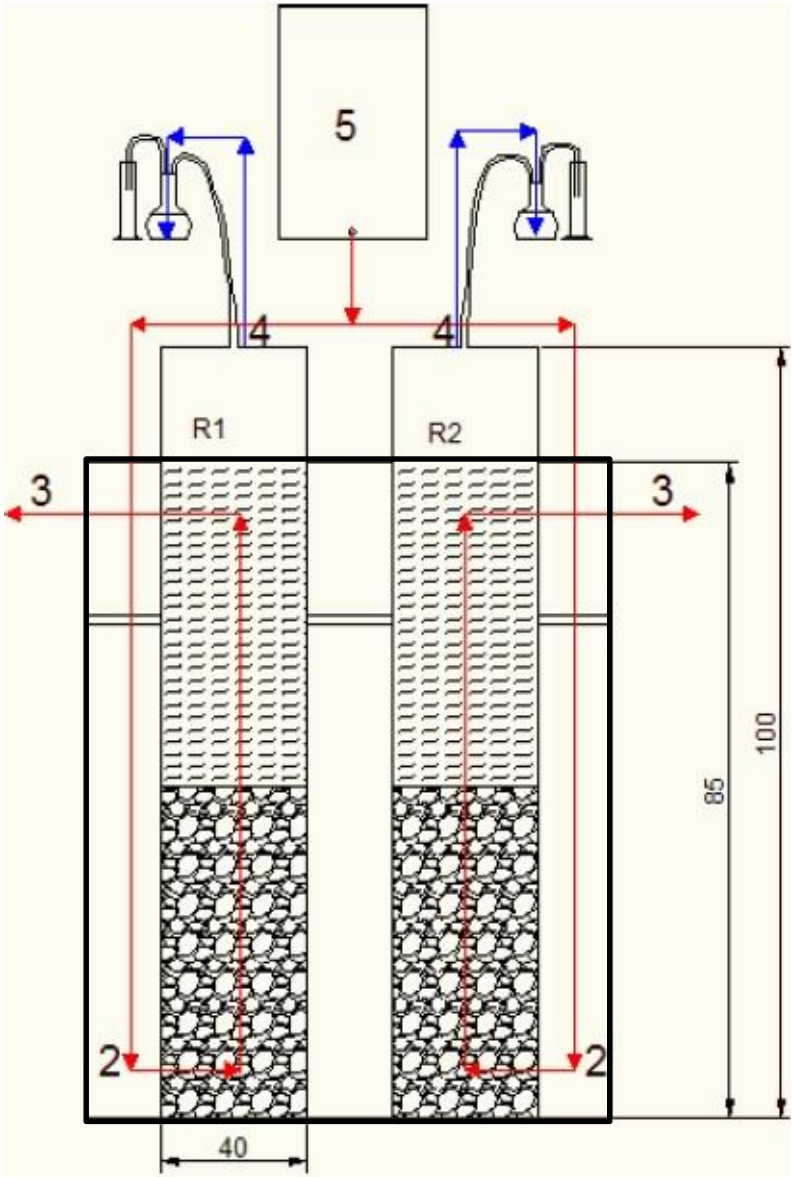

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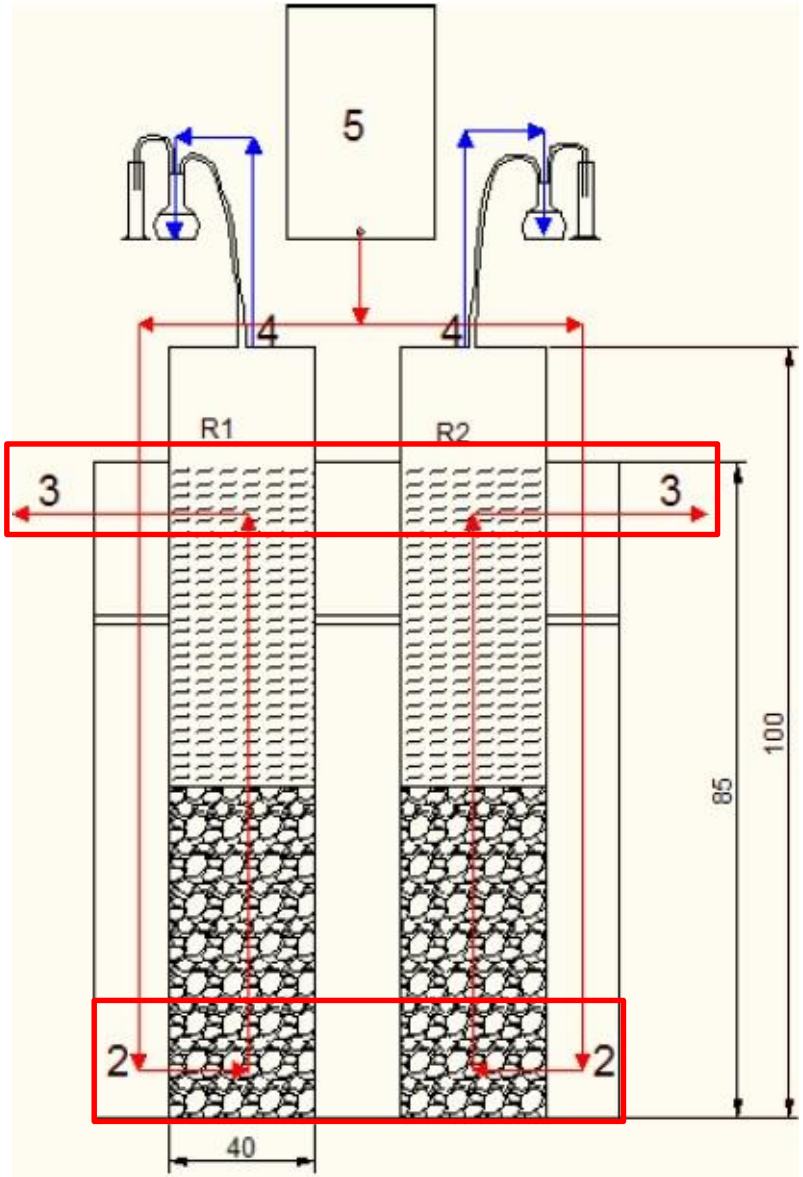

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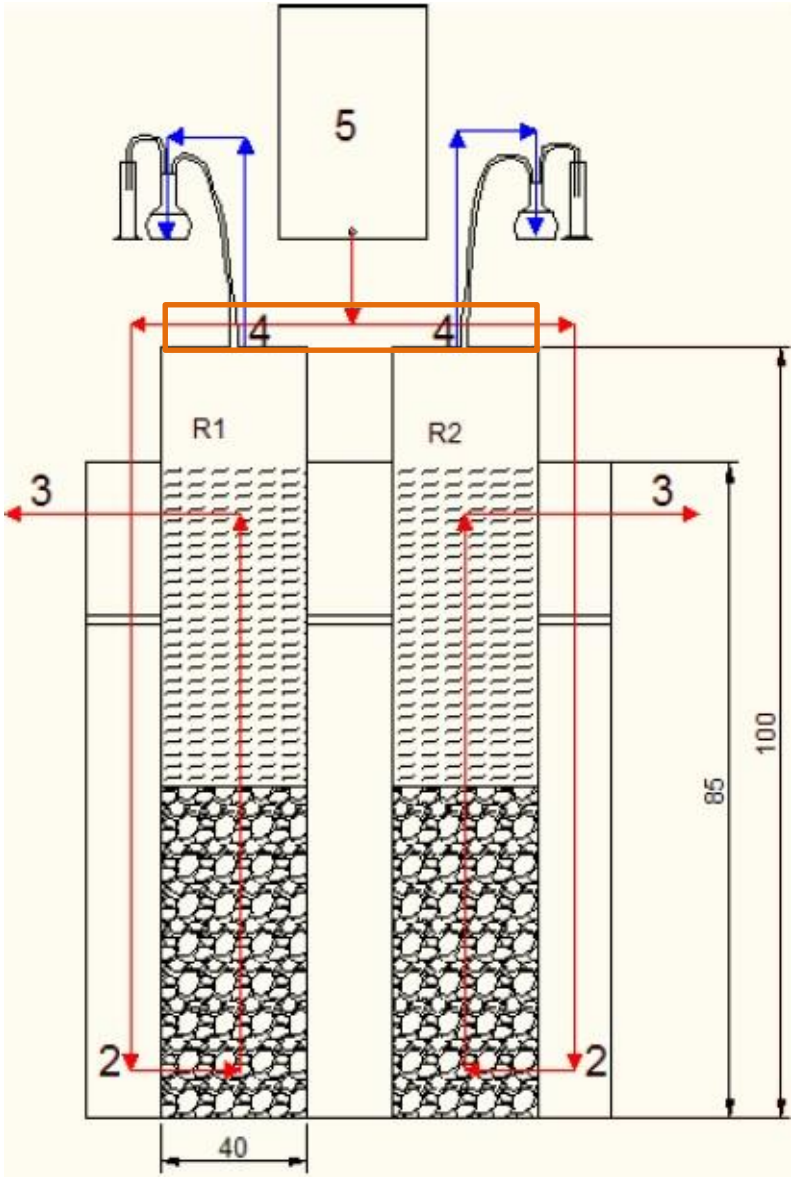

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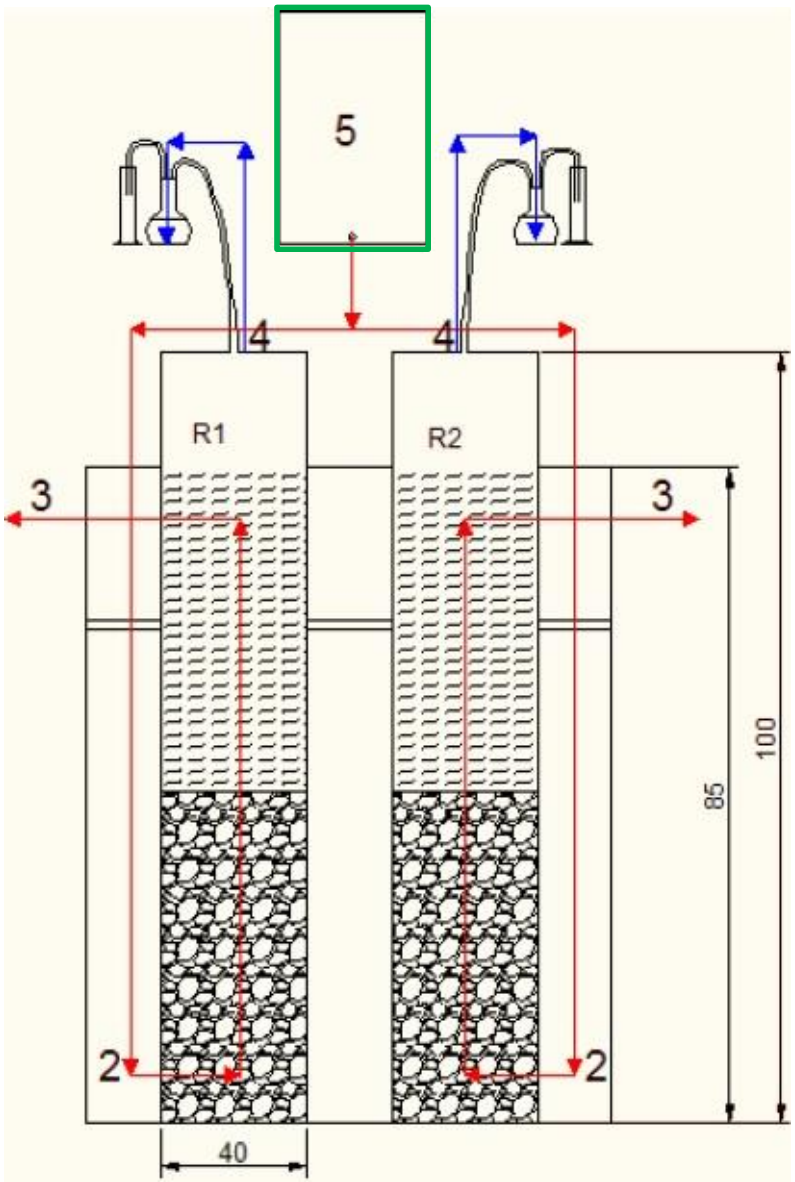

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limestone

Materials and Methods

- Substrate and anaerobic sludge
  - Sugarcane vinasse originated from ethanol factory located ***400 km from local study*** with ***100 ºC initial temperature***;
  - **After 6 hours** dropped to **60 ºC** and **pH 4.3**;
  - Biomass used from **cattle manure** (8kg), common in **rural area** (inoculated with water – 20.5 L).

cattle manure

Materials and Methods

- Samples and vinasse used in this experiment
  - Standard Methods for the Examination of Water and Wastewater (APHA, 2012);
  - chemical oxygen demand (COD), total solids (TS), volatile solids (VS), fixed solids (FS), alkalinity (Alk.), volatile acidity (VA) and pH;

Materials and Methods

Table 1. Concentration of raw vinasse applied in UASB and concentration of treated vinasse used to *Brachiaria Brizantha* cv. Xaraés growth.

Parameters	Concentration raw vinasse	Concentration treated vinasse
pH	4,3	7,1
COD ($g.L^{-1}$)	16,7	2,0
Total solids ($mg.L^{-1}$)	14.253,0	1.464,0
Total volatile solids ($mg.L^{-1}$)	12.652,3	504,0
Total fixed solids ($mg.L^{-1}$)	1.477,0	960,0
Total phosphorus ($mg.L^{-1}$)	17,1	7,0
Total nitrogen ($mg.L^{-1}$)	3,1	40,0
Calcium ($mg.L^{-1}$)	60,9	47,5
Iron ($mg.L^{-1}$)	4,6	1,86
Potassium ($mg.L^{-1}$)	420,0	223,0
Magnesium ($mg.L^{-1}$)	105,9	51,3
Manganese ($mg.L^{-1}$)	17,4	0,89
Zinc ($mg.L^{-1}$)	3,3	0,09

Materials and Methods

- Soil collected in this study presents sandy medium texture

Table 2. Physico-chemical analysis fo the soil.

	Parameters												
	pH	OM	K	Ca+Mg	Al+H	S	T	V	Fe	Mn	Zn	Cu	B
Units		$g.dm^{-3}$			$cmol.dm^{-3}$			%			$mg.dm^{-3}$		
Values	4,97	6,86	0,03	0,3	2,34	0,33	2,67	12,36	144,96	12,02	0,94	0,9	0,09

Materials and Methods

- Initial growth of *Brachiaria Brizantha* cv. Xaraés
  - Four treatments;
    - Control (without fertilizer addition);
    - Fertilization;
    - Raw vinasse (535 $m^3.ha^{-1}$);
    - Treated vinasse (567 $m^3.ha^{-1}$).

Materials and Methods

After seeding

Materials and Methods

- Vinasse application and seedling evaluation
  - 15 days after sowing;
  - 2 cuts (after 40 and 80 days);
  - Heigh;
  - Fresh and dry total mass;
  - Fresh and dry leaf mass;
  - Fresh and dry stem mass.

  - The multiple mean comparisons within treatments were performed using Tukey's test at a 0.05 error level

Materials and Methods

leaf

stem

Results and discussion

Table 3. Start up UASB reactor operation results: removal (%) of COD and solids, pH, alkalinity and volatile acids and biogas production compared to organic load, hydraulic detention time and temperature range.

°C	days	HDT	OL	COD (%)	TS (%)	TVS (%)	TFS (%)	Alk.	VA	pH	biogas $mL.L^{-1}.d^{-1}$
36 ± 2	0-29	7	0,5	70,6±3,2	69,0±5,3	78,6±4,7	20,7±6,2	35,0±12,1	242,2±16,1	8,4±0,9	125±15
40 ± 2	30-59	5	1,3	75,1±2.1	81,9±3,7	86,5±2,2	27,6±4,3	50,0±10,3	292,4±14,9	8,1±0,8	165±25
44 ± 2	60-89	5	3,3	77,3±8,5	82,0±9,2	88,1±4,1	34,5±3,7	80,0±9,8	74,4±12,7	7,8±0,5	200±22
48 ± 2	90-104	4	6,7	91,7±1,9	91,7±3,1	91,0±2,9	35,0±4,9	120,0±11,6	60,0±13,4	7,7±1,0	350±35
52 ± 2	105-119	3	8,5	98,2±1,0	84,0±2,9	94,5±1,9	35,5±2.5	150,0±14,7	83,6±7,1	8,7±1,1	500±15
> 55	120-141	3	11,7	99,5±0,9	89,7±1,8	96,0±2,5	35,7±1.7	170,0±15,5	76,8±8,2	8,5±1,4	500±18

°C: temperature; HDT: hydraulic detention time (days); OL: organic load ($gCOD.m^{-3}.day^{-1}$); TS: total solids (%); TVS: total volatile solids (%); TFS: total fixed solids (%); Alk.: Alkalinity ($mgCaCO_3.L^{-1}$); VA: Volatile Acidity ($mgCH_3COOH.L$-1).

Results and discussion

Table 4. Height measurements and fresh and dry mass, leaf and stem, in the first and second cut.

Treatment fertilizer	Height	FTM	LFM	SFM	DTM	LDM	SDM
	cm	gram					
First cut							
Control	42,17 b	2,27 b	2,09 b	0,19 b	0,67 b	0,39 b	0,03 b
Chemical fertilizer	92,17 a	47,80 a	37,42 a	9,93 a	11,47 a	9,43 a	1,97 a
Raw vinasse	36,92 b	2,97 b	2,71 b	0,24 b	0,60 b	0,55 b	0,02 b
Treated vinasse	37,92 b	2,04 b	2,0 b	0,06 b	0,37 b	0,37 b	0,07 b
CV	22,03	34,04	31,69	32,51	20,85	22,42	17,73
Second cut							
Control	69,33 c	42,02 b	26,42 b	15,62 b	8,37 b	5,78 b	2,59 b
Chemical fertilizer	88,83 a	123,18 a	72,97 a	50,80 a	32,84 a	21,06 a	11,79 a
Raw vinasse	69,67 bc	45,53 b	28,20 b	17,30 b	9,36 b	6,42 b	2,94 b
Treated vinasse	78,33 b	41,76 b	25,72 b	16,65 b	8,83 b	5,76 b	3,07 b
CV	6,96	26,15	24,70	27,21	23,50	22,32	23,53

Means followed by the same letter in the column do not differ by Tukey test ($p > 0.05$). FTM = fresh total mass; LFM = leaf fresh mass; SFM = stem fresh mass; DTM = dry total mass; LDM = leaf dry mass; SDM = stem dry mass; CV = coefficient of variation.

Materials and Methods

After 80 days, second cut

Conclusions

- The inoculum (cattle manure) demanded 140 days to stabilize (start-up);
- The reactor had removed 99% for COD in the thermophilic range, showed higher solids removal;
- With increasing temperature (mesophilic - thermophilic) the gas production increased more than 40%;
- The use of raw vinasse did not significantly influence the vegetative development of *Brachiaria brizantha* cv. Xaraés. The treated vinasse benefited the growth after 40 days after sowing (“second cut”);
- The use of treated vinasse at UASB (55^{o}C) provides biogas generation and effluent to the use of irrigation has a lower pollutant load to the soil and water, allowing its use in the development of forage crop for use as food at livestock production system.

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