ORIGINAL ARTICLE

Treatment and Use of Pig Residual

Tratamiento y uso de residuales porcinos

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ABSTRACT: In the work different proposals were analyzed for the treatment of pig residual, starting from the analysis of the properties of the pigs effluents of a biodigestor located in "Ranchuelo "for their possible use as organic fertilizer; as well as their decontamination possibility. The effect decontaminant of a slow filter of sand was proven combined with the action of a aquatic plant called lettuce of water (*Pistia stratiotes*) before different dilutions to the effluent in common water. The following treatments were valued: T0 (not dilute), T1 (17%), T2 (14%), T3 (12.5%), T4 (11%) and T5 (10%). The different treatment proposals were valued before different variables. In the effluents, their physical-chemical and microbiology characteristics were determined, previous and later to their step for the bio filter and the oxidation lagoons. It took like indicative cultivation the corn (*Zea mays*), being evaluated their morphs-physiologic parameters. In most of the effluents, the microbial load could be reduced using the bio filter and its combination with valued oxidation lagoons, obtaining values below the Cuban norms. The analysis of the effluents like bio-fertilizer showed results referred to the germination percent that oscillated among a minimum of 33,3% (T2) and a maximum of 80% (T3) regarding the control TOc (46,6%).

Keywords: Pig Effluents, Slow Sand Filters, Oxidation Lagoons, Pistia Stratiotes.

RESUMEN: En el trabajo se analizaron diferentes propuestas para el tratamiento de residuales porcinos, a partir del análisis de las propiedades de los efluentes porcinos de un biodigestor ubicado en "Ranchuelo "para su posible uso como fertilizante orgánico; así como su posibilidad de descontaminación. Se probó el efecto descontaminante de un filtro lento de arena combinado con la acción de una planta biorremediadora lechuga de agua (*Pistia stratiotes*) ante diferentes diluciones efectuadas al efluente en agua común. Fueron valorados los siguientes tratamientos: T0 (no diluido), T1 (17%), T2 (14%), T3 (12.5%), T4 (11%) y T5 (10%). Se valoraron las diferentes propuestas de tratamiento ante diferentes variables. En los efluentes, se determinaron sus características físico-químicas y microbiológicas, anteriores y posteriores a su paso por el biofiltro y las lagunas de oxidación. Se tomó como cultivo indicador el maíz (*Zea mays*), evaluándose sus parámetros morfo fisiológicos. En la mayoría de los efluentes, la carga microbiana pudo ser reducida utilizando el biofiltro y su combinación con lagunas de oxidación valoradas, obteniendo valores por debajo de las normas cubanas. El análisis de los efluentes como bioabonos mostró resultados referidos al porciento de germinación que oscilaron entre un mínimo de 33,3% (T2) y un máximo de 80% (T3) respecto al control TOc (46,6%).

Palabras clave: efluentes porcinos, filtros lentos de arena, lagunas de oxidación, Pistia stratiotes.

INTRODUCTION

The slow filtration in sand has been broadly used as method to improve the quality of the water in different regions of the planet, due to its simplicity in the operation and to its numerous advantages. In the last decades these they have been implemented to improve the conditions of the water after meteorological events and natural disasters, when the treatment is truncated by the traditional methods of improve or it stops individual use in the housings, having great welcome.

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It has been demonstrated that the slow filters of sand have worked in a successful way in areas so much urban as rural around the world, many of which subsist in a precarious way, allowing to improve the public health and quality of the inhabitants' life of these areas, even, it has been evidenced their good operation and the positive impact that generate this type of technologies.

In recent Francesena (2016); Villareal (2017); Fabregat (2019); Llama (2019); Sánchez (2020) and Ramírez (2021), the method of slow sand filtration has been evaluated like alternative to obtain not very aggressive effluents of oxidation lagoons to the environment with local materials diminishing costs and offering an alternative before the current conditions of these effluents, which are poured to the means with high value of contamination.

Some of these studies, they have referred to the implementation of systems of slow sand filters to laboratory scale, with the purpose of the effluents that spill in oxidation lagoons trying it stops later on to measure certain parameters of the same ones and to compare them with the Cuban regulatory schemes of waste waters NC-855: 2011 (2011); NC-27: 2012 (2012); NC-1095-2015 (2015).

In the investigations indexed previously, it has been able to verify that the slow sand filters are a good alternative to improve the quality of the bio digesters effluents in production, obtaining high percentages of removal of DQO, DBO_5, ST, fecal coliformes, tolerant water heater and *Pseudomonas aeruginosas* in investigations recent envelope the topic at national and international level.

Motivated by some of the investigations indexed previously and like part of an investigation topic in course of the Department of Agricultural Engineering of the Central University "Marta Abreu" of Las Villas, which has been of interest for private and state producers. With these records, it decided to carry out in the central region of Cuba (province of Villa Clara), the taking of samples of effluents of the biodigestor of the private producer "Niosbany" for their study and valuation, reason why, the results obtained in this investigation could be used as example for the development of future engineering projects that it offer solutions to the outlined problem, with the result that it is defined as investigation objective the following one: To evaluate the effect of the treatment of pig residual and their linking with oxidation lagoons, for different dilution percent's in water.

MATERIALS AND METHODS

Use of the gravel, sand, zeolite and vegetable coal bio filters. Use of the oxidation lagoons to reduced scale. Proposals of treatment plants to real scale.

Fabregat (2019), it built a bio filter to laboratory scale with materials of the territory of Villa Clara and Sancti Spíritus mainly following some of the approaches obtained in the bibliographical revision: as mean size of the particles of the utilized materials. This bio filter was used in the present investigation.

Materials

The used materials are of own acquisition and for it was used it a plastic tank of high-density polyethylene (PAD) to 5 L, which was filled forming layers or strata with the following materials: it burdens, washed sand, zeolite, burdens and vegetable coal. The heights of the filtering means were: 8, 8, 6, 3 and 5 cm respectively.

The added volumes of the different utilized substrates as filtering material were: it burdens: 900 cm^3; washed sand: 2250 cm^3; zeolite: 1125 cm^3; it burdens: 450 cm^3 and vegetable coal: 900 cm^3. The natural zeolite comes from the location of San Juan of the Yeras, Ranchuelo, Villa Clara, presenting more than 61% of material zeolite, with a grain among 0,5 - 2,5 mm and half diameter of 1,1 mm. The slow sand filters were built in recipients of 5 L or 0,005 m^3, like it is shown in the Figure 1 with an approximate area of 0.024 m^2, and a volume of 0, 0047 m^3. In the tank one, was placed the vegetable coal and the gravel; in the tank two, the zeolite was placed and in the tank three the washed sand was placed. The effluents spent in having cracked by each one of the filters.

FIGURE 1. Slow Sand Filters made.
Source: (author file).

The contact beds are separated in strata, the gravel was not sifted, the sand, the zeolite and the vegetable coal present a quite regular grain, the zeolite possesses an irregular grain for what separated the smallest fraction to fulfill the obtained approaches of the consulted bibliography, for such a reason it decided to carry out the granulometric separation using a sieve 4. The materials before described they underwent a maturation process, for that which the different filters contained common water stored for more than 30 days. The parameters to control in the filtration operation were: operation speed, effluent volume, elapsed time, and % expansion, flow of air and effluent for the laundry; as well as the physiochemical characteristics of the tributary and effluent.

As flowing they were considered the pure samples of the respective valued oxidation lagoons; as effluents they were considered the tributaries dilute filtrates and gone by oxidation lagoon to reduced scale of the different valued investigative rehearsals. In each one of these lagoons it spills 1000 ml of the effluents with their later respective dilutions to the step of these for the bio filter. The oxidation lagoons to small scale were built leaving of large bottles of water of 5 L (5 000 cm^3) of capacity, which were cut, like it is shown in the figure 2, six lagoons were used, one for each treatment. In these, soil was added (795, 8 g), filtered effluent (1000 mL), calcareous stone (116,7 g) and lettuce of water (*Pistia stratiotes*) (16,5 g). Once in the oxidation lagoons to reduced scale. The effluents was allowed to rest five days in the lagoons. Finally 1000 ml was collected of each one of the lagoons and they were taken to the ENAST laboratory for its valuation (ENAST-Cuba, 2023). In the ENAST laboratory surrendered 12 samples: 2 without filtering (SF); 10 filtered in bio filter and gone by oxidation lagoon (FL), which were coded and surrendered in different dates of the investigation (ENAST-Cuba, 2023). They were analysis object the samples of effluents of the biodigestor "Niosbany" (6). The Fig. 2 shows particulars from the built oxidation lagoons to reduced scale.

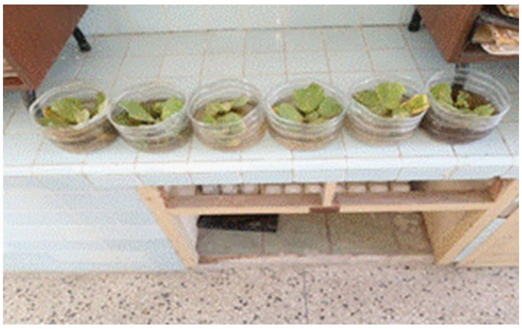

FIGURE 2. Oxidation Lagoons built to reduced scale. Source: (author file).

Taking of samples initials

It was carried out in the province of Villa Clara, in the biodigestor "Niosbany", located to the exit from Ranchuelo to 1 km of the national freeway. In all the cases 5000 ml/samples was collected.

In all the taken samples the procedure was made according to the specifications of the laboratory, following the due custody chain and conservation.

Calculation of the thickness of the contact bed in the filters to reduced scale

The loss of charge (that is to say, the fall of pressure) that takes place when the clean water flows through a means of clean filter can calculate starting from well-known equations.

The flow through a clean filter of size of ordinary grain (that is to say, of 0, 5 mm to 1, 0 mm) to the ordinary filtration. The speeds (4.9 to 12.2 m/h) they would be in the range of flow to laminate represented by the equation of Kozeny that is dimensionally homogeneous (that is to say, can use any consistent unit that is dimensionally homogeneous) (Letterman, 2010).

But as the water to try is not cleans it kept in mind a simpler calculation and it was considered the calculation by the equation of Darcy (Ec. 1) adapted to a filter (Sánchez, 2014).

$$(H1 - H2) = \frac{vf}{k} * L \qquad \text{Ec.1}$$

Where:
L = thickness of the layer of sand;
K or Kf = permeation coefficient;
H1 = peel of water hang-over or to try;
H2 = peel of treated water;
vf = filtration speed in the channel of sand.

Physical - chemical analysis of the tributaries, effluents

In the tributaries and effluents that pay to the oxidation lagoon investigated the following indicators they were determined:

- pH;
- Electric conductivity (C.E);
- Total Coliformes and Tolerant water heater;
- Oxygen Biological Demands (DBO_5);
- Chemistry Oxygen Demands (DQO);
- Solid sedimentables (S sed);
- Total nitrogen (Nt);
- Fatty and oils (Ga);
- Total phosphorus (Pt);
- Relationship of absorption of sodium (RAS);
- Solid soluble total (SST).

All these analyses were carried out in the laboratories of the enterprise of Analysis and Technical Services (ENAST) of Santa Clara. Villa Clara (ENAST-Cuba, 2023).

Permeability of the materials used in the slow filters

The permeability of the slow sand filter was determined in real way based on the studies made by Villareal (2017); Sánchez (2020); Ramírez (2021). The procedure for soil rehearsals was carried out according to that specified by the American Society of Rehearsal and Material (ASTM D 2434, 1997).

Flow of design of the filter slow filter

In this case, with the speed of filtration of the samples and the area of the filter it proceeded to calculate the design flow by means of the Ec. 2.

$$Q = A * vf \qquad \text{Ec. 2}$$

Where:
Q = flow, cm^3/s (mL/s);
To = area of the traverse section of exit of the filter, cm^2;
vf = speed of the investigated fluid, cm/s.

Efficiency of removal of the chemical oxygen demand (DQO)

For this indicator the expression was used 3

$$EF = \left(\frac{\text{DQOe} - \text{DQOs}}{\text{DQOe}} \right) * 100 \qquad \text{Ec. 3}$$

Where:
DQOe- in flowing;
DQOs- in effluents.

Efficiency of removal of the biological oxygen demand (DBO_5)

The expression was 4

$$EF = \left(\frac{\text{DBO5e} - \text{DBO5s}}{\text{DBO5e}} \right) * 100 \qquad \text{Ec. 4}$$

Where:
DBOe- DBO_5 in flowing;
DBOs- DBO_5 in effluents.

Determination of the microbial load in the effluents

Once collected the effluents in plastic bottles of 1500 ml, was taken to the laboratory of the ENAST-Cuba (2023), quickly Santa Clara, Villa Clara, where Total coliformes and Tolerant coliformes water heater were determined. In this case they repeat the later analyses to their step for the slow filter (bio filter) and the oxidation lagoons. With the obtained values it was analyzed if the effluents fulfills the established Cuban norms NC-27: 2012 (2012) y NC-1095-2015 (2015) regarding Total Coliformes and Tolerant Coliformes water heater.

Determination of the quantity of soil and bio fertilizer to use in the treatments

Determination of the quantity of soil and bio fertilizer to use in the treatments to scale of gavels. For the realization of these calculations it left of the type of soil analysis object in the biodigestor "Niosbany" (soil to brown soft carbonated). In this case, knowing the apparent density of the soil (1, 28 g/cm^3), it spent to the determination of the weight of the hectare-furrow, by means of the expression 5.

- Area of a hectare - 10 000 m^2 = 1.108 cm^2;
- Volume of a hectare - 1.108. 20 cm^2 = 2.109 cm^3 (20 cm of depth)

Then the weight of the hectare-furrow was determined by rule of three. Being:
1.28 g/cm^3- 2.1 cm^3

$$X - 2.10^9 \qquad \text{Ec.5}$$

X= $2.56.10^9$ g/ha
X= $2.56.10^6$ kg/ha
Norm of bio fertilizer application to real scale. This depends on the conditions of fertility of the soil and of the system of irrigable (unirrigated land or with watering) where the cultivation is sustained.

In the case of this study, to know the quantity of bio fertilizer to apply in the different bags for treatment, it took an application dose to real scale of 20 t/ha. Then by means of rule of three, according to expression 6 are obtained:
$2.56.10^6$ kg - 20000 L

$$(1)Kg - X \qquad \text{Ec. 6}$$

X= $0.82.10^{-2}$ L
X= 8.2 mL

Experiments under semi-controlled conditions

An experiment was mounted under semi-controlled conditions to determine the effect of the effluents obtained in the oxidation lagoon of the private pig biodigestor "Niosbany" as bio fertilizer. These effluents was evaluated by different dilution percent in common water (of well). In such a way, the experiment was executed with six treatments and the control, in each treatment three replicas were mounted, for a total of 21 polyethylene bags stuffed with 1 kg of soil of the private pig biodigestor "Niosbany". The utilized soil as substrate was gone by sieve of 4 mm and like indicative plant was used the corn (*Zea mays* L.). Later on it proceeded to sow five seeds of corn, for bag. The corn possesses a germination percent in badge Petri of (90.00%), next 10 mL of the effluents was added with the degree of dilution investigation object, filtrates and gone by the oxidation lagoons to reduced scale to reason of 2 mL for seed. In each bag, 200 ml of distilled water was added by bag, to achieve that the humidity of the soil outside of 80% of its field capacity. Two watering's were applied (200 mL of distilled water /bag) every six days, during the period of investigation. The bags received natural illumination and after twelve days the plants were harvested and the germination percent was determined; as well as the morph physiologic parameters of the indicative cultivation in the treatments and control according to the investigated degree of dilution.

The dilutions investigation object were assumed keeping in mind what establishes the norm NC-855: 2011 (2011).The norm points out that: the mixtures of the effluent (vinaza + it dilutes) they should be in the ranges of 1:6 and 1:10 (residual of alcohol, residual of raw or another water), and that these dilutions are the appropriate ones to water and to fertilize the sugar cane. This methodology was also used with the effluents of the private pig biodigestor "Niosbany". The following treatments were used:

Non dilute T0-Effluent (1000 mL); 1-T1-Effluent dilutes 1/6 (166 mL + 834 mL water); 2-T2-Effluent dilute 1/7(143 mL+ 857 mL water); 3-T3-Effluent dilute 1/8(125 mL+ 875 mL water); 4-T4-Effluent dilute 1/9(111 mL+ 889 mL water); 5-T5-Effluente dilute 1/10(100 mL+ 900 mL water); T0c. Control (without effluents application).

Later to the step of the effluents diluted by the slow sand filter, they take the effluents of the oxidation lagoon (to small scale) pacified during five days of agreement with the dilutions prepared by treatments. The flasks were sealed tightly and they stayed to an ambient temperature in the protected laboratory of the incidence of the sunbeams. In the alone control distilled water was applied. In each one of the bags with soil and indicative cultivation (corn) the dose was applied settled down by treatment and replicas, to observe the results obtained in the morphs physiologic characteristic of the indicative cultivation.

Morphs physiologic parameter of the indicative plants

Height of the Plants (AP) and Longitude of the Root (LR): they were measured with a metric tape, in cm.

Weigh Fresh of Foliage and Root for separate (PFF and PFR): recently harvested they are weighed in an analytic scale, in grams.

Dry weight of Foliage and Root for separate (PSF and PSR): the samples were put in the stove to 65 °C during 48 hours and then they were weighed in an analytic scale, in grams.

For the above-mentioned, the protocols and procedures were continued settled down in the Cuban norms NC.

Statistical analysis

For the statistical prosecution the professional application software STATISTICA was used, Version 7 on Windows XP. Analysis of Variance of simple classification was applied with the test of comparison of stockings of Tukey HSD, verifying the homogeneity of the variance, for treatments with same number of repetitions for the determination of the statistical differences among the different valued treatments.

RESULTS AND DISCUSSION

Calculation of the thickness of the contact bed: Substituting in the equation of Darcy (Ec.1) adapted to a filter.

The thickness of the contact bed threw a value similar to L = 5 cm, however it was assumed = 8 cm, practically 62.5% superior to that determined by calculation, in order to obtaining a good filtrate of the pig effluents, to the being these a fluid with high value of contamination.

Flow of design of the slow sand filter

Using the expression 2.

A value of Q=0, 02 $x10^{-6}$ m^3/s was obtained. It clears up that for the determination of the flow of design of the filter common water was used as fluid, nevertheless also it was determined with all the efluentes with its different investigated degrees of dilution.

Efficiency of removal of the Chemical Oxygen Demand (DQO)

Using the expression 3

Efficiency of removal of the Biological Oxygen Demand (DBO_5).

Using the expression 4

It was obtained the results that it shows the Table 1.

Of the analysis of the Table 1, it could appreciate that the effluents coming from all the treatments of the oxidation lagoon of the "Biodigestor Niosbany" evaluated, they fulfill the norm NC-27: 2012 (2012) in both valued samples (No.1759 and No.1764) once these effluents is filtered and gone by the respective oxidation lagoons it could appreciate a reduction of this variable as it diminishes the degree of dilution, showing a good effect from the slow sand filters when reducing the value of the DQO, that which agrees with previous investigations reported by Ramírez (2021). According to Torres (2015) in the biological reactors the control of the quantity of dissolved oxygen is one from the critical values to control.

It was obtained the results that it shows the Table 2.

In the effluents of the "Biodigestor Niosbany" (Table 2), it could appreciate that all the treatments of the sample (Not 1759), and they fulfill that settled down by the Cuban norm NC-27: 2012 (2012). however when going by the bio filter (No.1764), in all the treatments, a reduction of the value of this variable was presented, the same as with the previous variable, that which reaffirms the good work of the slow sand filter.

TABLE 1. Efficiency of removal of the DQO

Treatment Effluents dilute (%)	DQO (mg L^{-1}) Before. No. 1759 SF	DQO (mg L^{-1}) After. No. 1764	% Efficiency of removal of DQO
T0- (n. d)	424	N.e	
T1- (16, 66 %)	424	300	70,75
T2- (14, 28 %)	424	150	35,37
T3- (12, 5 %)	424	100	23,58
T4- (11, 11%)	424	64	15,09
T5- (10 %)	424	56	13,20

N.e - not valued; N.d-not diluted: 1759 SF (without filtering) and 1764 FL (filtrates and gone by oxidation lagoons).

TABLE 2. Efficiency of removal of the DBO_5

Treatment Effluents dilute (%)	DBO_5 (mg L^{-1}) Before. No. 1759 SF	DBO_5 (mg L^{-1}) After. No. 1764 FL	% Efficiency of removal DBO_5
T0- (n. d)	200	N.e	
T1- (16, 66 %)	200	170	85,00
T2- (14, 28 %)	200	150	75,00
T3- (12, 5 %)	200	60	30,00
T4- (11, 11%)	200	30	15,00
T5- (10 %)	200	25	12,50

N.e - not valued; N.d-not diluted: 1759 SF (without filtering) and 1764 FL (filtrates and gone by oxidation lagoons).

Determination of the microbial load in the effluents

Of the analysis of the different treatments in the Laboratory of the ENAST, it was obtained the results that it shows the Table 3. A comparison is presented among the samples 1759 SF (without filtering) and 1764 FL (filtrates and gone by lagoons).

The results obtained in the Total coliformes previous to the filtration process in the analyzed treatments, show contamination (above that specified in the NC-1095-2015 (2015). In the case of the Tolerant coliformes water heaters, one could observe a low contamination; however, later to the bio-filtration process, so much in the Total coliformes as in the Tolerant coliformes water heater one could observe that it was able to lower the polluting load in all the treatments executing that specified by the Cuban norm NC-1095-2015 (2015). Reaffirming the good work of the bio filter group and the valued oxidation lagoons. These investigations contribute to the study of the topic, which had been valued in previous works made for Martínez *et al.*, (2014); Sosa (2015); Francesena (2016); Fabregat (2019) and Sánchez (2020) in residual of the sugar industry. In this aspect it should stand out that the dilute effluents and filtrates and the use of the bio-remedy plant (*Pistia stratiotes*), in oxidation lagoons to reduced scale didn't show goods necrosantes in this plant, neither inhibitory effect of their growths, as if they were found in the work of Francesena (2016), using pig effluents with technical similar of bio-filtrate. That which showed that the virulence or aggressiveness of these effluents once filtrates went inferior to the effluents of the bio digesters investigated for Francesena (2016) and Fabregat (2019), which used like bio-remedy plant the lentil of water (*lemna minor*).

Results referred to the pH and the conductivity

These results are shown in the Table 4.

TABLE 3. Microbiologic analysis of the previous and later analyzed effluents to the filtrate

Treatment Effluents dilute (%)	Total *coliformes* (NMP/100) before 1759 SF	Tolerant *coliformes* (NMP/100) before 1759 SF	Total *coliformes* (NMP/100) After 1764 FL	Tolerant *coliformes* (NMP/100) After 1764 FL
T0- (n. d)	1,2x10^3	170	N.e	N.e
T1- (16, 66 %)	1,2x10^3	170	610	70
T2- (14, 28 %)	1,2x10^3	170	390	130
T3- (12, 5 %)	1,2x10^3	170	240	33
T4- (11, 11%)	1,2x10^3	170	440	79
T5- (10 %)	1,2x10^3	170	290	33

N.e - not valued; N.d-not diluted: 1759 SF (without filtering) and 1764 FL (filtrates and gone by oxidation lagoons). NC-1095-2015 (2015). Permissible limits: NMP: Total Coliformes <1000 NMP/100 mL; Tolerant Coliformes water heater <1600 NMP/100 mL

TABLE 4. Investigated obtained results of the residual ones contrasted with the NC-855: 2011 (2011)

*Approaches	Treatment valuated	Conductivity (C.E) mmhos/cm	Sales solubles totales (SST) ppm	Relación de adsorción de sodio (RAS)	pH
Good		< 1,50	< 960	< 4	6-7
Regular		1,50-1,80	960-1150	4-7	5-6 ó 7-7,8
Bad		1,80-2,40	1150-1530	7-10	4-5 ó 7,8-8,4
Cannot be use		> 2,4	> 1530	> 10	< 4 ó > 8,4
No.1759	T0- (n. d)	1,947	n.e	n.e	9,02
No.1760 FL	T1- (16, 66 %)	0,821	n.e	n.e	8,11
No.1761 FL	T2- (14, 28 %)	0,616	n.e	n.e	7,90
No.1762 FL	T3- (12, 5 %)	0,556	n.e	n.e	7,43
No.1763 FL	T4- (11, 11%)	0,937	n.e	n.e	7,20
No.1764 FL	T5- (10 %)	0,819	n.e	n.e	7,47

TO - non dilute effluent, non-filtrate; n.e-no evaluated; No.1761… .1764 FL - diluted Effluents, filtrates and gone by oxidation lagoons to small scale. Among parenthesis, percent of dilution of the effluents.

In the variable conductivity, the treatments T1, T2, T3, T4 and T5 (they are classified as well); TO (it is classified as bad). In the variable pH, the treatments T3, T4, T5 (they are classified as regular), T1 and T2 (they are classified as bad) and TO (cannot be use).

Indicative morphs physiologic parameter in the indicative plants

In the Figure 3 the behavior of the germination percent is observed in the different valued treatments.

Of the analysis of the Fig.3, it was observed that except the treatment T2, the other treatments overcome to the control (TOc) in this indicator by the variable germination percent (mean value), included the non-dilute effluent of the "Biodigestor Niosbany". This result contrasts favorably with the results obtained for Francesena (2016) in pig residual coming from bio digesters and for Sánchez (2020) in sugar residual of the "Carlos Baliño" sugar mill which didn't obtain results so satisfactory with regard to the germination percent, using methodologies similar to the employees in this investigation.

In the Figure 4, the effect of the treatments of the effluents is shown on the height of the plant (AP).

One could observe that the best behavior was obtained with T4 (371, 42 mm), being the worst the treatment T1 (292, 22 mm) regarding the control TOc (306, 42 mm). This demonstrates that the dilution and filtrate of the effluents influenced positively in this variable.

In the Fig. 5, the relative results are shown to the longitude of the root.

One could observe that the best behavior was obtained with T2 (140, 00 mm), being the worst the treatment T4 (100, 00 mm) regarding the control TOc (147, 85 mm). In this case no treatment overcame to the control. Other morphs physiologic properties are not presented in this work by question of available space in this publication.

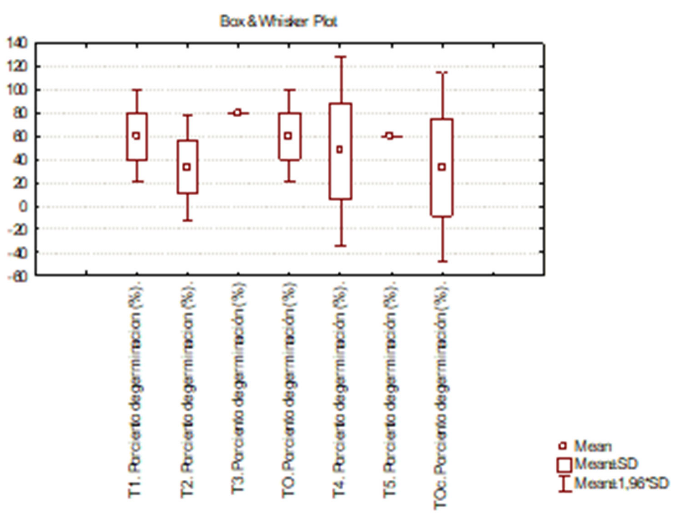

FIGURE 3. Effect of the treatments on the germination of the indicative cultivation plant (corn). TOc, TO, T1, T2, T3, T4 and T5. (Efluentes Biodigestor "Niosbany").

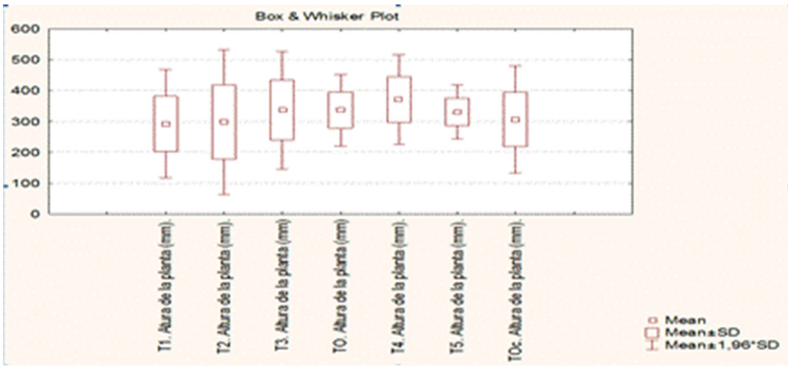

FIGURE 4. Effect of the treatments on the height of the indicative plant. TOc, TO, T1, T2, T3, T4 and T5.(Effluents Biodigestor "Niosbany").

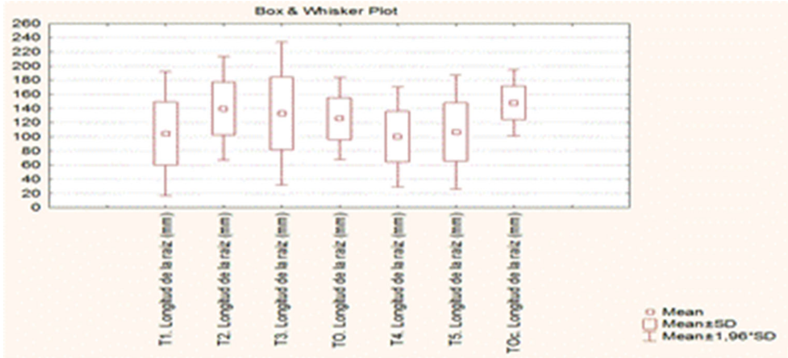

FIGURE 5. Effect of the treatments on the longitude of the root of the indicative plant. TOc, TO, T1, T2, T3, T4 and T5. (Effluents Biodigestor "Niosbany").

CONCLUSIONS

- It confirmed the good work group of the bio filter and the oxidation lagoon to reduced scale.
- The step of the effluents for the bio filter and oxidation lagoon, allowed to reduce the pH values, electric conductivity, oxygen chemistry demands (DQO) and biological oxygen demand (DBO_5), allowing the use of the effluents in the fertilization.
- The germination percent, except in the treatment T2, overcomes to the control (TOc), what reaffirms that the step of these effluents for the system (slow sand filter and oxidation lagoon) it caused the decrease of the aggressiveness of these effluents.

RECOMMENDATIONS

- To carry out a study about the efficiency in the decontamination of the waste waters of the oxidation lagoons in sugar mill.
- To execute the proposal from the slow bio filter to real scale with the purpose of correlating the obtained results to small scale.

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