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IMPACT OF EMBIOFERT TREATMENT IN SWINE MANURE TREATMENT PONDS

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Abstract: The swine manure has a high organic load, pathogenic microorganisms, copper, zinc, aluminum, nitrogen, potassium which, when sent without previous treatment, trigger numerous problems, such as contamination in groundwater, river pollution, eutrophication. Several methods are described in the literature that aim to minimize the environmental impact caused by the direct disposal of waste in the soil, among them we can highlight the use of enzymes in aerobic treatment ponds that aim to use as biofertilizer. In this work, the reduction of chemical and biochemical oxygen demand was 93.42% and 97.12% in 103 days. Organic matter reached a reduction of 58.71% and 83.20%, sedimentable solids 90.24% and 99.63%, fecal coliforms 98.91% and 99.10%, aluminum was 91.65% and 96.68%, copper 79.50% and 96.69%, zinc 82.44% and 94.56%, phosphorus 87.20% and 93.60%, total nitrogen 30% and 62.5% in 46 and 103. Therefore, this treatment can be used in rural properties that aim to use swine manure as a biofertilizer.
Keywords: Swine manure, enzymes, aerobic treatment, swine farming.

INTRODUCTION

PIGS

The high growth of the world population and its demand for food provided strong pressures for the development of the agricultural sector. Brazilian swine farming, like other agribusiness production chains, has grown significantly in the last fourteen years. In 2019, Brazil produced 3.983 million tons of pork, making it the 4th largest meat producer worldwide (ABPA, 2020).

Brazil has the third largest herd of swine in the world, with more than 32 million heads, surpassed only by the United States and China. Most of the swine production is concentrated in the western and southern regions of the state and is characterized by small properties (95.3% have up to 50 hectares), where family labor predominates (SILVA, 2000; PERDOMO et al, 2003).

While the development of swine farming allowed for gains in scale and productivity, it resulted in a considerable increase in manure production. A large part of the investments in a swine production system is related to the implementation of technologies that reduce the polluting potential of manure. Additionally, there is an increasing search for technological solutions for the economic use of waste from this production, such as biofertilizer and, above all, the generation of electricity from biogas generated by swine manure (LEITÃO, 2018).

ENVIRONMENTAL PROBLEMS

The swine production model currently in Brazil is in an intensive system and in confinement. In this system, animals are confined in reduced areas, which increases the amount of liquid waste that is generated (KUNZ, HIGARASHI, OLIVEIRA, 2005). These liquid residues have a high polluting load, being higher than that of other species, such as humans, because while BOD, biochemical oxygen demand, per capita of a swine of 85 kg of live weight, varies from 189 to 208 g/animal/ day, the domestic one is only 45 to 75 g/inhabitant/day (OLIVA et al., 2002).

The waste consists of urine, water for cleaning and drinking fountains, pathogenic microorganisms, heavy metals (copper and zinc used in rations as growth promoters, for example), ration residues. The feces constitute solid or pasty manure, while the liquid manure of pigs contains organic matter, nitrogen, phosphorus, potassium, calcium, sodium, magnesium, manganese, iron, zinc, copper and other elements included in the diet of animals (CARDOSO, OYAMADA, SILVA, 2015). Its composition and quantity vary according to the management adopted, as well as zootechnical (size, weight, breed), environmental (temperature and humidity) and dietary factors (digestibility, fiber and vitamin content) (ITO, GUIMARÃES, AMARAL, 2016).).

Due to the high load of nutrients, the main polluting components are nitrogen, phosphorus, heavy metals, aluminum, zinc, copper and pathogenic microorganisms (ITO, GUIMARÃES, AMARAL, 2016). Improper management of swine manure when disposed directly on the ground without prior treatment can cause serious damage to water resources, which causes eutrophication of water bodies, alters aquatic biodiversity, imbalance between different cultures, proliferation of organisms harmful to human health and such as leptospirosis, tularemia, foot-and-mouth disease (OLIVEIRA and NUNES, 2005).

In addition, another problem is the emission of volatile gases in the urine and feces of pigs. According to Lopes, Filho and Alves (2013), ammonium carbamate is a compound present in swine manure, with an unpleasant odor and with the ability to dissociate into ammonia (NH_3) and carbon dioxide (CO_2) gases. Ammonia is a gas that causes adverse effects to humans, such as eye, nasal and skin irritation, in addition to generating disturbances in the neural conduction of the brain. Thus, it appears that swine waste also has a direct impact on the comfort of the population, in the form of bad odors and proliferation of insects (ITO, GUIMARÃES, AMARAL, 2016).

TREATMENTS USED AND THEIR DESTINATION

Among the possible alternatives found for the destination of swine manure is its use in agriculture as a fertilizer. Its use on rural properties can enable the development of an integrated production system. These systems correspond to a set of productive alternatives that diversify sources of income, generating greater economic and social stability (CARDOSO, OYAMADA, SILVA, 2015The selection of a management system is based on several factors, such as the potential for pollution of the manure, need for manpower, available area, system operability, legislation, reliability and costs. Therefore, the main treatment techniques combine physical and biological processes. Physical methods include decanting, centrifuging, sieving and/or pressing. Biological methods, on the other hand, involve the degradation of organic matter by the action of microorganisms and enzymes, resulting in a stable material free from pathogenic organisms. The management of swine manure can be done by the following processes aimed at storage and treatment (DARTORA; PERDOMO; TUMELERO, 1998; DIESEL; MIRANDA; PERDOMO, 2002; PITZ; POSSAMAI; PEREIRA, 2009):

a) manure: functions as a storage of waste whose treatment aims to capture the volume of liquid waste for the occurrence of biological fermentation of organic matter. It is easy to operate and construct and has a low installation cost. However, it requires a high cost of storage, transport and distribution.

b) biodigesters: these are closed spaces intended to generate methane for energy production. Its main advantage is the possibility of energy reuse, generation of biofertilizer. However, they require high investment cost.

c) composting: these are places where bacterial fermentation takes place, resulting in a fertilizer that can be used in agriculture. Its main disadvantage is the need for a system to separate the solid part (which is composted) from the liquid part.

d) Biological/enzymatic treatment: is a treatment in which enzymes and/or beneficial microorganisms are applied to aerobic treatment ponds. Enzymes, produced by microorganisms, are proteins that have the function of catalyzing (accelerating) chemical reactions and breaking down/degrading organic matter. It is recommended in this treatment the use of aerators for the entry of oxygen, facilitating the homogenization and accelerating the decomposition of the organic matter. One of its main advantages is the possibility of disposing of the manure treated with biofertilizer, it also reduces the emission of unpleasant odors, it is easy to install and helps in the homogenization and reduction of the stabilization time of the organic matter of the ponds/manure ponds. This technology has the need for a technician to accompany the installation, application and guidance.

CONTROL PARAMETERS FOR DESTINATION AS FERTILIZER

The quality of the biofertilizer depends on parameters such as the chemical and biochemical demand of oxygen, nitrogen, copper, zinc, phosphorus and aluminum that directly influence the quality of the soil and plants.

The chemical and biochemical oxygen demand is one of the most important parameters in characterizing the degree of pollution of a water body. RICHARD and NETTO (2007) define COD and BOD as a measure that allows the assessment of the pollution load of water bodies and domestic and industrial sewage, in terms of the amount of oxygen necessary for its total reduction (oxidation or consumption by microorganism). That is, it depicts the content of organic matter in sewers or bodies of water and is therefore an indicator of the potential consumption of dissolved oxygen in the water. Thus, the higher the COD and BOD, the greater the need for oxygen and the greater the degree of pollution.

Nitrogen is an extremely important macronutrient for plant development. It can be absorbed either in the form of cation ($NH4^{+}$) as of anion (NO^{3-}). According to Bredemeier & Mundstock (2000), in many production systems, nitrogen availability is almost always a limiting factor, influencing plant growth more than any other nutrient. However, its excess can cause abnormal growth, with mass accumulation, delaying reproductive development. In addition, when present in excess, nitrogen can hinder the absorption of other nutrients, such as magnesium (Mg), calcium (Ca) and potassium (K), by creating a kind of competitive inhibition (SILVA, 2000).

In the case of phosphorus, according to SEGANDREDO (2001) it is noted that applications of raw swine manure in large amounts in crops are not absorbed by plants, this fact is linked to the availability of phosphorus in the anionic form. $H_2PO_4^-$ and cationic HPO_4^{2-}, being lost by erosion and leaching.

Excess copper and zinc can cause inhibition of nutrient absorption, changes in physiological and biochemical processes, and damage to the structure of the root system, impairing plant growth and development. Aluminum is one of the main factors responsible for the low performance of plants, inhibiting root growth and contaminating soils and groundwater (AMBROSINI et al., 2016).

The present work aims to evaluate the presence of smudge (dry matter on top of the pond), larvae, flies, reduction of chemical and biochemical demand for oxygen, nitrogen, copper, zinc, phosphorus, aluminum and coliforms before and after the EmbioFert treatment. This treatment consists of a composting additive, called Embio 3000, and the Embio propellant.

The compost additive has in its composition enzymes (amylases, proteases, among others) that have the role of accelerating the enzymatic hydrolysis processes. The impeller, on the other hand, is an equipment that promotes aeration, homogenization and the injection of microbubbles. This equipment operates with an intermittent cycle that provides the stabilization of excess nutrients in the ponds. This technology provides a large volume of movement and incorporation of oxygen, in scope and depth.

METHODOLOGY

PROPERTY USED TO CARRY OUT THE EXPERIMENT

The experiment was carried out in a cement dunghill located in Pato Bragado in the state of Paraná. The property has 5 sheds with a capacity of 3100 heads of pigs in the finishing phase.

IMPLEMENTATION OF THE THRUSTER AND THE EMBIO 3000

The experiment started when the manure was practically full, with approximately 900 m^3 of swine manure and the entrance of manure into the treatment pond was completely sealed. Then, the 2CV Embio engine was installed, initially keeping it on and working in an interval of 15 minutes on and 60 minutes off. 450 grams of Embio 3000 product were added and applied at 2, 46 and 103 days of treatment.

TEST ANALYSIS

Approximately 3 liters of waste were collected at the beginning of treatment, called time 0, with 46 days and 103 days of EmbioFert treatment for laboratory tests. The samples were stored in a refrigerated container at 4°C and sent to the accredited laboratory located in the city of Cascavel-PR. The analyzes performed were: chemical and biochemical oxygen demand (COD and BOD), organic matter, potassium, copper, zinc, aluminum, nitrogen, phosphorus, potassium, sedimentable solids and fecal coliforms.

RESULTS

CHARACTERISTICS OF THE TREATMENT POND

It was noted that during the EmbioFert treatment:

a) There was no presence of smudge in the upper part of the treatment pond;

b) Significant reduction in the presence of larvae and flies soon after the start of treatment

c) Presence of foam;

d) More homogeneous manure, facilitating management for use as Biofertilizer.

The significant reduction of the smudge, whose material is deposited in the upper part of the pond, is caused by the junction (intermolecular bond) of excess organic matter. This material is responsible for clogging pipes, hoses and burning plants when deposited in excess. Its removal during the treatment is caused by the presence of the Embio propellant that provides the agitation and the insertion of oxygen allowing the bonds between the organic matter to be broken. The propellant also favors that the organic matter is hydrolyzed by the Embio 3000 and consumed by aerobic and anaerobic microorganisms. In Figure 1 it is possible to visualize the EmbioFert treatment.

The significant reduction in the presence of larvae and flies comes from the enzymes that are present in the Embio 3000, and from the microorganisms that are present in the swine manure. According to BRAVO et al., 2011 the diversity of species of the genus Bacillus is responsible for excreting molecules with toxic action against different insects and larvae. These microorganisms are present in the waste and, when provided with the optimal conditions of oxygen and organic matter, they can excrete substances of interest.

The presence of foam and homogenization of swine manure is produced by the breaking of specific bonds of organic matter, resulting from the degradation and reduction of excess contaminants. Providing a more homogeneous waste, as can be seen in figure 2.

REDUCTION OF CONTAMINANTS

The chemical and biochemical oxygen demand (BOD and COD), organic matter, sedimentable solids, fecal coliforms, aluminum, copper, zinc, phosphorus and nitrogen in the three treatment times (time 0, 43 and 103 days) can be visualized in figures 3, 4 and in Table 1.

As exemplified in Figures 3, 4 in Tables 1 and 2, there was a reduction of 74.58% and 93.42% in COD at 46 and 103 days after the start of treatment, whereas the BOD of 79.16% and 97, 12% at 46 and 103 days of treatment. According to SANTANNA (2010), the COD indicates both biodegradable and non-biodegradable substances in the effluent and is adopted as representatives of the carbon sources available in the reaction medium.

According to Jardim and Canela (2004), the biological treatability of an effluent is evaluated by the BOD and the recalcitrance of this same organic load by the COD. Thus, for a given effluent, the COD/BOD ratio indicates which type of oxidation will be effective in destroying the organic load present. If the COD/BOD ratio is less than 2.5, it is readily biodegradable. If the ratio is between 2.5 and 5.0, this effluent will require care in choosing the biological process in order to have a desirable removal of organic load, and if the COD/BOD ratio is greater than 5, then the biological process has little chance of success and chemical oxidation appears as an alternative process (JARDIM and CANELA, 2004).

In the present study, at the beginning of treatment, the COD/BOD ratio was 1.42, at 46 days 1.74 and 3.27 at 103 days. It is noted that the treatment used showed a reduction of COD and BOD throughout the treatment, reaching values below 5.0 in the COD/BOD ratio, indicating a good degradation by the biological part.

Organic matter reached a reduction of 58.71% and 83.20%, sedimentable solids 90.24% and 99.63%, fecal coliforms 98.91% and 99.10%, aluminum was 91.65% and 96.68%, copper 79.50% and 96.69%, zinc 82.44% and 94.56%, phosphorus 87.20% and 93.60%, total nitrogen 30% and 62.5% in 46 and 103 days after treatment respectively. These results prove that the EmbioFert treatment significantly reduces the concentration of excess contaminants that make up swine manure.

In many biological processes, microorganisms need enzyme precursors for their development, such as aluminum, copper, zinc and phosphorus. The reduction of these contaminants in the pond indicates the potential of the existing microbiota in the treatment pond capable of using these micronutrients as precursors of specific metabolic pathways.

Treatment techniques have always aimed to generate purified effluents from their main pollutants, in order to lessen the impact of their discharge into receiving courses. Among the most used systems are those that use intermittent aeration and continuous flow of effluent. In these systems, alternately repeated aerobic and anaerobic conditions make the process of ammoniacal nitrogen gasification effective (WARNER et al, 1986). The non-

Figure 1 – Propellant and Embio 3000

Source: authors, 2022

Figure 2 - Pig manure treatment pond with EmbioFert

Source: authors, 2022

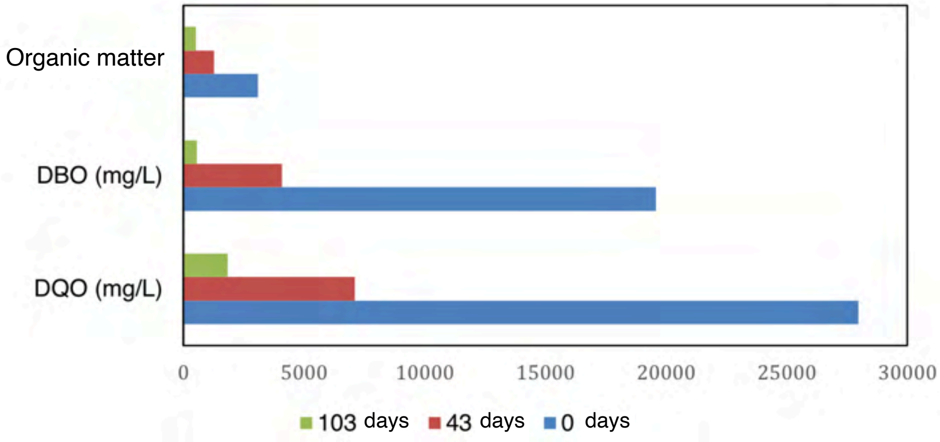

Figure 3 -Reduction of DQO, DBO and mattter.

Source: authors, 2022.

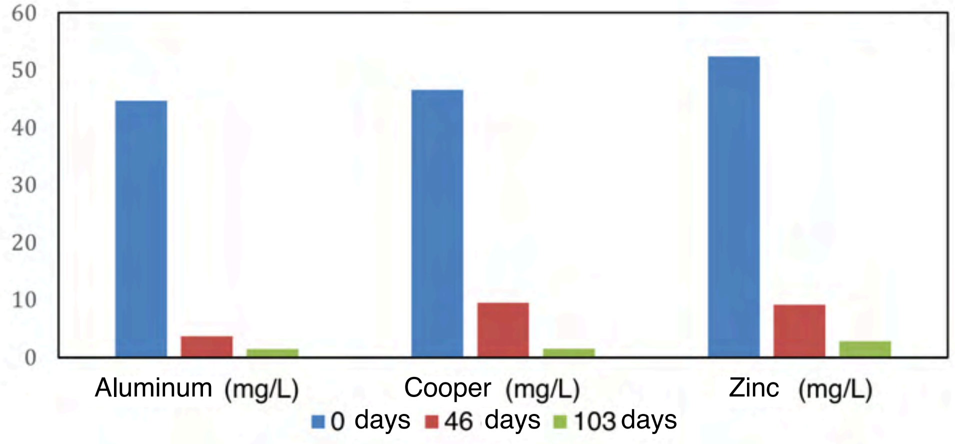

Figure 4 -Aluminum,coper and zinc reduction.

Source: authors, 2022.

Time (days)	DQO (mg/L)	DBO (mg/L)	Organic matter (mg/L)	Sólids sedimentable (ml/L)	Coliforms faecal(UFC/100 mL)
0 (start)	27979,01	19590	3093,70	410	1.560.000
46	7113,21	4082,14	1.277,10	40	17.000
103	1840,99	562,96	519,75	1,5	14.000

Table 1 – Data obtained from the reduction of DQO, DBO and organic matter.

Source: authors, 2022.

Time (days)	Aluminum(mg/L)	Copper(mg/L)	Zinc (mg/L)	Phosphor (mg/L)	Nitrogen (mg/L)
0	44,7	46,6	52,4	506,3	3121,21
46	3,73	9,55	9,2	64,8	2183,06
103	1,48	1,54	2,85	32,4	1169,49

Table 2 – Data obtained from the reduction of aluminum, copper, zinc, phosphorus and nitrogen.

Source: authors, 2022.

aeration period prevents the accumulation of nitrite, resulting in high nitrogen removal. The N-NOx produced during the aeration period is immediately reduced in the non-aeration period to nitrogen gas, under stable pH conditions (OSADA et al., 1991).

The agitation process, insertion of oxygen in the intermittence process and biological catalysts (enzymes from 3000) favor biological processes and simulate in an accelerated way what happens in nature. In the water body, organic matter is converted into inert mineralized products by purely natural mechanisms, a phenomenon known as self-purification (HIGA, 2005).

The biological treatment of waste therefore takes advantage of a set of microorganisms with different characteristics for the degradation of organic matter, distinguishing four treatment groups: aerobic, anoxic, anaerobic and combined, providing a rich microbiota (VAN HAANDEL and LUBBE, 2019).

CONCLUSION

In view of the results presented above, it is possible to conclude that the EmbioFert treatment:

a) It has a high rate of removal of contaminants;

b) Reduces the incidence of flies and larvae;

c) Homogeneous waste, without the presence of smudge;

d) Provides the use of swine manure as a Biofertilizer;

e) Embio 3000 is a product that does not cause environmental ;

f) damage; Development of a rich microbiota and an efficient activated sludge;

g) The time of 46 days of treatment showed a more significant reduction of contaminant when compared to 106 days;

h) The Embio thruster did not present any mechanical problems, it has high durability and resistance.

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