SWINE MANURE STORAGE TIME INFLUENCE ON CHEMICAL FLOCCULATION AND SOLID-LIQUID SEPARATION EFFICIENCY

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1 INTRODUCTION

Animal production has changed considerably in the recent years moving from extensive to a very intensive systems. Such developments were important to reduce the logistic and production costs but brought an environmental pressure in regions with high animal density and low soil absorption capacity. This new scenario needs new management strategies adapted to this production model (Vanotti et al., 2009).

Swine production is following this concentration tendency and examples can be found in different parts of the world (Kunz et al., 2009a; Martinez, 2009). If in on hand the confined animal feeding operations (CAFOs) can reduce the production costs, on the other hand increase the localized demand for inputs and water, increasing the environmental impact caused by the residues generated in the production (Bradford et al., 2008).

Swine production effluent has a large amount of suspended solids and its removal using conventional physical separation processes (settled or screened) is possible but not always efficiently. Animal manure solid separation is a good strategy that needs be used as a part of the whole treatment, because it can increase the recovery of nutrients in the solid fraction and the possibility to use it with higher agronomic value (Burton, 2006). A solid-liquid separation can also prevent particulate material overloading the subsequent chemical or biological treatment.

To promote a good efficiency in solid-liquid separation, additives acting as flocculants can be added to the effluent. Inorganic salts, such as aluminium sulfate or ferric chloride are usually added as a coagulant in solid–liquid separation processes (Westerman and Bicudo, 2000). However, the problem of metal salts for manure treatment is that the concentration of metal species in the sludge can restrict its agronomic use (Steinmetz, 2007). Therefore, there is an increasing interest in the use of organic coagulants, synthetic or natural, that are biodegradable and environmentally safe. The fact that it is not always necessary to adjust the pH using organic flocculants makes this process more practical than the use of inorganic salts (Zhang and Lei, 1998; Sievers et al., 1994).

Natural organic polymers have been used for animal manure solid–liquid separation. Steinmetz et al. (2007) studied the efficiency of solid–liquid separation using modified natural extracts from black wattle (*Acacia mearnsii*) in swine manure, and obtained a removal efficiency of 90% for chemical oxygen demand (COD) and 98% for effluent turbidity. The high efficiency and low environmental impact of natural polymers enlarged the market for these kinds of products in Brazil.

Furthermore, raw manure quality depends of temperature and storage time in the houses and pits. These factors can significantly change the characteristics of the stored manure solubilising certain solids due to a degradation processes (Zhu et al., 2000, Kunz et al., 2009b). In this study, was evaluated the influence of storage time on swine manure solid-liquid separation (SLS) efficiency using a natural coagulant extracted from black wattle.

2 MATERIAL AND METHODS

2.1 Manure sampling and storage

The swine manure was collected at the experimental swine production system of the Swine and Poultry National Center of the Brazilian Agricultural Research Corporation (Embrapa) in Concordia, Santa Catarina State, Brazil (27º18'S, 51º59'W). Samples of fresh manure were collected directly from the reception pits inside finishing houses and the total solids (TS) of all samples adjusted, with water to 3% w/v. After this, the samples were homogenized and distributed in 2 liters fractions, on polyethylene bottles, and stored at dark and room temperature (20 ± 2 ºC). Triplicate of samples were used in solid-liquid separation assays after 0, 1, 3, 7, 14, 21 and 28 storage days.

2.2 Solid-liquid separation (SLS) set up

The SLS tests were carried out with a 2 L jar test (Milan, model JTC.3P, Brazil) using two cationic organic polyelectrolytes

Coagulant; (modified tannin extracted from Black Acacia) at 10% v/v (Veta Organic, Brazilian Wattle Extracts, Brazil)

Floculant: polyacrilamide (PAM) as an auxiliary flocculant at 0.01% w/v (Ativador Q, Brazilian Wattle Extracts, Brazil).

The solutions were prepared immediately before use, to avoid the loss of efficiency in SLS by degradation of reagents.

The tests were performed in a sequence of five steps:

Step 1: The samples were screened to remove the particulate matter with a diameter greater than 2 mm;

Step 2: To 2 L of screened manure stirred at 120 rpm, were added 60 mL of tannin (10% v/v), maintaining agitation for 1 minute;

Step 3: After this, were added 20 mL of PAM (0.01% w/v) and reduced agitation at 40 rpm maintained for 5 minutes;

Step 4: Than the agitation was stopped and the sample kept at rest for 15 minutes for solid sedimentation;

Step 5: Measured the volume of sludge and collected 200 mL for analysis of supernatant and sludge.

For control was used the same procedure but with no addition of tannin and PAM solutions, only using the manure.

2.3 Analysis

Total suspended solids (TSS), total Kjeldhal nitrogen (TKN), chemical oxygen demand (COD) and total phosphorous (TP) were analysed according to the methodologies described in APHA (1995). Sludge volume was determined in the jar test.

3 RESULTS AND DISCUTION

The Figure 1a shows the residual COD on liquid fraction (clarified) after SLS. The COD residual on the clarified fraction increase from 5000 mg/L to more than 9000 mg/L representing a decrease in COD supernatant removal efficiency from 70% (day 0) to 45% (day 28). Also were observed an increase of TSS in raw manure supernatant, also shown in Figure 1b. These results show that soluble organic fraction increased following the same tendency observed by Zhu (2000) and Kunz (2009b), clearly soluble components cannot be separated efficiently by the chemicals after SLS. The increase of TSS in raw manure supernatant can be explained by anaerobic degradation (eg.: solids fraction hydrolysis).

Figure 2 present the volume of settled solids for control samples and samples after SLS. After 3 days of storage, settled solids with addiction of flocculant, increased from 640 to more than 900 mL L^{-1}, showing fluffy flocs. The sludge sedimentation depend of floc characteristics, according to Eckenfelder (1989) the charges and zeta potential of suspended solid surface was directly relationship with them capacity to settling. The anaerobiosis during the storage can produce modification on flocs surface and is feasible this implicate directly the efficiency in SLS systems.

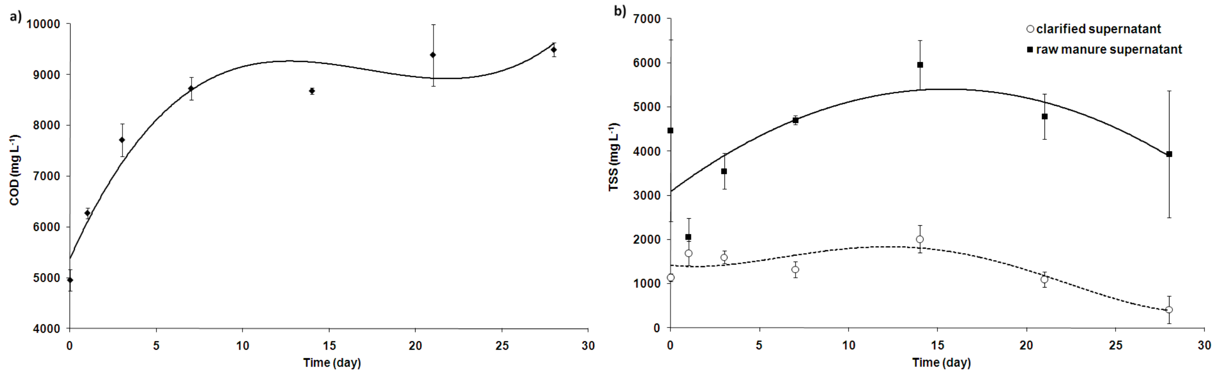

FIGURE1 **Residual COD on liquid fraction (clarified) after solid separation; and b) TSS difference before and after separation on supernatant.**

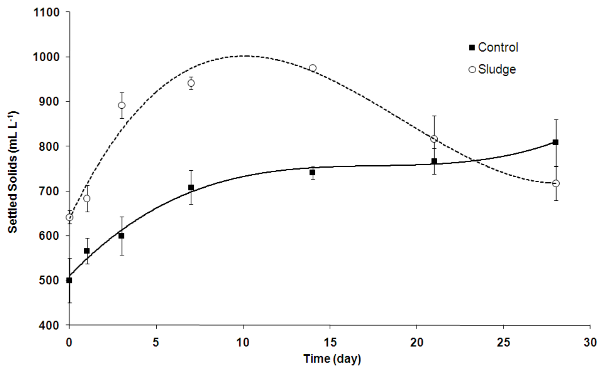

FIGURE2 **Settled solids (sludge volume) after homogenization and settled for 15 minutes. Squares represent raw manure sample without chemical coagulant addition (control) and circles represent after SLS (sludge).**

It was also observed an increase of TKN and TP in the supernatant as a function of increasing storage time (Figure 3a and 3b). The TKN in supernatant manure (control) increase from 770 mg/L (day 0) to 1152 mg/L (day 28). Similar behavior occur after SLS, the residual TKN increase from 500 mg/L (day 0) to 730 mg L^{-1} (day 14) around 40% than the present in the control sample. The TP in the control increase from 203 mg L^{-1} (day 0) to 330 mg L^{-1} (day 28) that is almost 40% more than TP in supernatant after SLS at day 28.

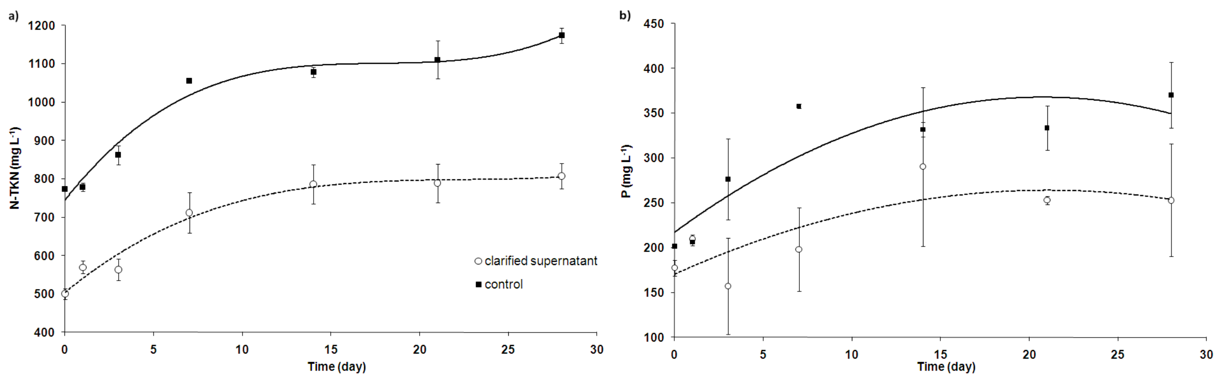

FIGURE3 **N-TKN for manure supernatant (control) and after SLS. b) total phosphorus for manure supernatant (control) and after SLS.**

4 CONCLUSIONS

Storage time affects the subsequent separation process due to the biodegradation of components of the swine effluent. The observed decrease on the SLS efficiency is due the solubilization of COD and nutrients. After 28 storage days, the soluble COD increase around 40%, TKN around 30%, TP around 20% indicating the necessity of a quick solid liquid separation process after manure generation to avoid the subsequent biological treatment process overload.

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