11th International Conference, Heraklion, Crete, Greece
Sept. 30 to Oct. 3, 2014
PHYTOTECHNOLOGIES

Federal University of Santa Catarina - Brazil

SWINE WASTE PHYTOREMEDIATION USING DUCKWEED (*Landoltia punctata*, Les & Crawford) IN A FULL SCALE PLANT.

Rodrigo de Almeida Mohedano[1], Rejane. H. R. Costa[1] and Paulo Belli Filho[1]
[1] Dept. of Sanitary and Environmental Engineering, Federal University of Santa Catarina, Florianópolis, Brazil.
Corresponding author email: rodrigomohedano@gmail.com

BACKGRAUND

The large amount of nitrogen and phosphorous compounds found in pig manure has caused ecological imbalances, with eutrophication of major river basins in the producing regions. Therefore, the aquatic macrophytes group named duckweeds (Araceae; Lemnoideae) have been successfully used for phytoextraction and rhizodegradation of nutrient and heavy metals from swine waste, generating further a biomass with high protein content. The present study evaluated the phytoremediation of nitrogen and phosphorus from swine waste using the duckweed *Landoltia punctata* and also their protein biomass production as by-product.

METHODOLOGY

During one year, the research was carried out through two full scale phytoremediation ponds with duckweeds (DP1 and DP2) installed in an small pig farm (figures 1 and 2). This ponds series received the effluent from a biodigester-storage pond, with a flow rate of 1 $m^3.day^{-1}$ produced by 300 animals. The content of Total Kjeldahl Nitrogen (TKN), $N\text{-}NH_3$, NO_2^-, NO_3^{2-}, Total Phosphorus (TP) and PO_4^{3-} was measured in influent and effluent of each pond according to APHA (2005) and pH, dissolved oxygen (DO) and temperature through a digital probe. The duckweed biomass was harvest twice a weak and their growth rate and nitrogen content was also evaluated.

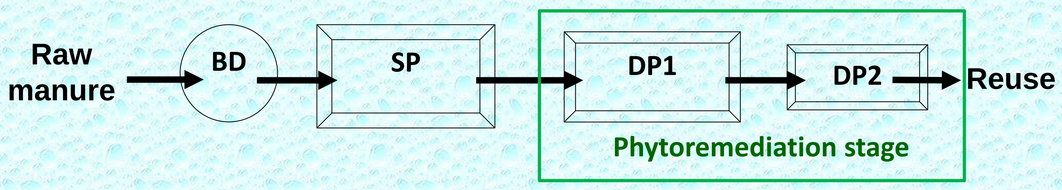

Figure 1. Whole Treatment System: BD- Biodigester; SP- Storage pond; DP1- Duckweed pond 1; DP2 - Duckweed pond 2.

Figure 2: (L) Phytoremediation pond with duckweeds; (R) *Landoltia punctata*

RESULTS AND DISCUSSION

Evan after anaerobic stabilization, a high nutrient concentration was found in effluent reaching 832mgNTK.L^{-1} and 92 mgPT.L^{-1}, considering average values. During experimental period approximately 28.5 kg of phosphorus and 260 kg of nitrogen was recovered from the water (or 0.47 gPT.$m^{-2}.day^{-1}$ and 4,4 gNTK.$m^2.day^{-1}$), however direct phytoextraction plays a partial role, mainly for nitrogen removed. Analysis of the biomass nitrogen content demonstrated a percentage of 6.6% ± 0.8 of total nitrogen (dw), in average, it is related with the high protein content in duckweed biomass reaching 41,25%. Only 28% of the nitrogen removal in DP1, was due direct phytoextraction by duckweeds, that is 81 kg of TKN (or 1.2 g TKN.$m^{-2}.day^{-1}$). Additionally, 72% was removed by nitrification and denitrification processes that could be assigned to rhizodegradation process. The roots zone provide a large area for a biofilm to attach, shelter and DO (2.1 mg DO.L-1 on the surface) to supporting nitrifying bacteria growth (figure 3).

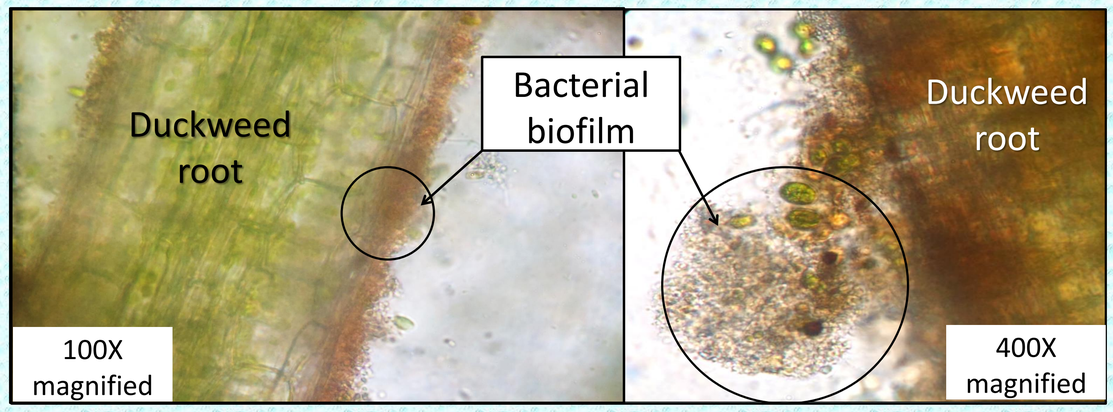

Figure 3. Bacterial biofilm attached on duckweed roots highlighted the rhizodegradation.

By contrast, in DP2 a different proportion was found; 96% of the total removed nitrogen was due to duckweed phytoextraction and only 4% was caused by denitrification (figure 4). The applied nitrogen load was vary larger in DP1 than DP2, in this case all of the nitrogen applied to DP2 was required for duckweed growth. Unlike nitrogen, phosphate compounds was strongly removed in DP1 and surely the phytoextraction process was the main route. Considering the surface growth rate about 18g.$m^{-2}.day^{-1}$(dry weight basis), the total yield was 68 ton.$ha^{-1}.day^{-1}$ with 35% of crude protein, in average.

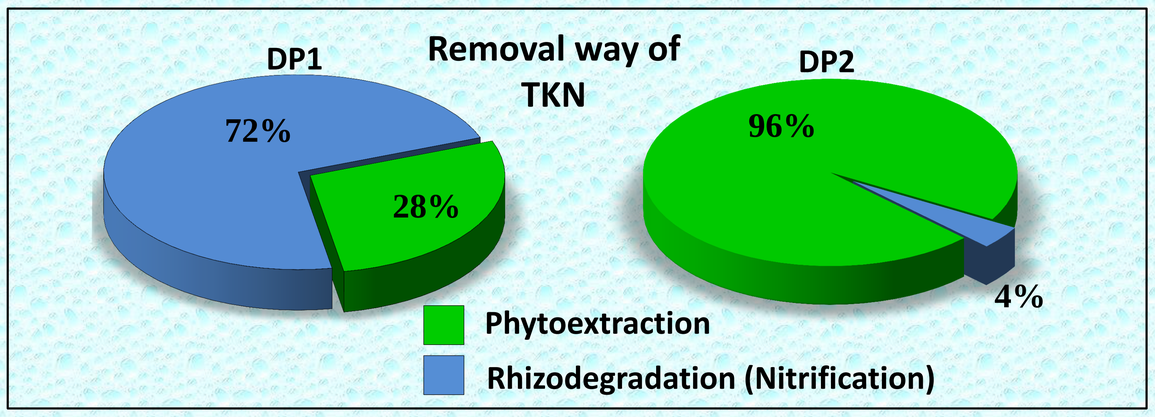

Figure 4: Different proportion of removal way of TKN (Total Kjeldahl Nitrogen) in DP1 and DP2 (Duckweed pond 1 and 2).

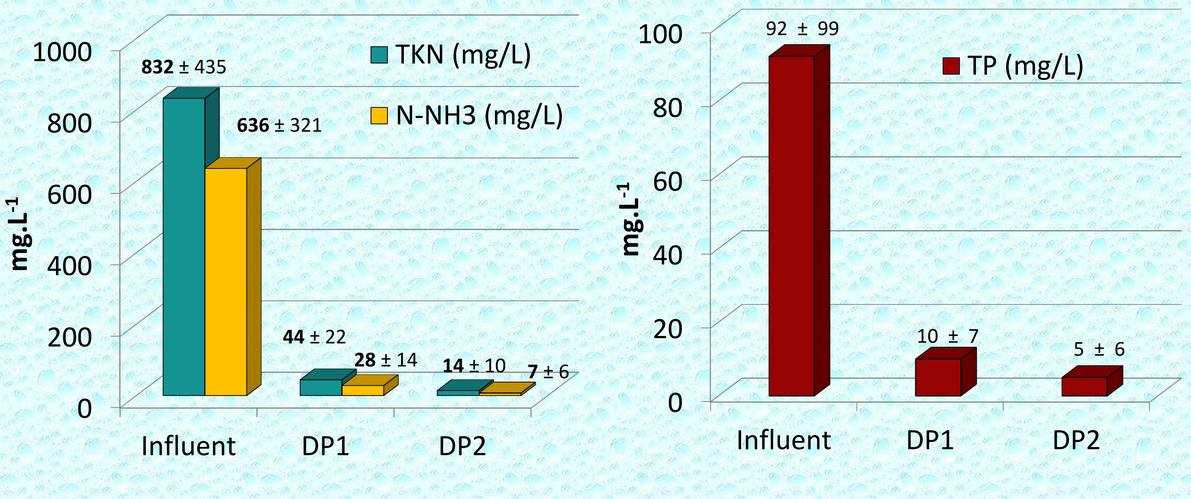

Figure 5. Concentration of TKN, NH_3 and Total Phosphorus (TP) in the effluent of each stage (DP1 and DP2 = Duckweed pond 1 and 2).

CONCLUSION

Due to the high rate of nutrient removal, and also the high protein biomass production, duckweed ponds revealed, under the presented condition, a great potential for phytoremediation of swine waste and animal food production simultaneously. Nevertheless, this technology should be better exploited to improve the sustainability of small pig farms in order to minimize the impacts of this activity on the environment.

Acknowledgment: