Research article

Using *Azolla Pinnata* for Wastewater Treatment from Poultry Farm

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Abstract Waste water from animal farm especially from poultry industry is one of the sources of non-point source water pollution in Thailand. Plants can be a practical tool for waste water treatment. Aquatic fern (*Azolla pinnata*) has been used to for organic matter, nitrogen and phosphorus removal from waste water and can be good for increase soil fertility. The objectives of this study were to use *Azolla pinnata* for poultry industry wastewater treatment and to assess the potential use of *Azolla pinnata* biomass for increasing fertility of soil resource. The results found that *Azolla pinnata* can reduce BOD of wastewater from slaughter to 41% and produce the biomass of *Azolla pinnata* 90, 167, 245% in 100, 50, 25% dilution of wastewater, respectively. This study demonstrated that *Azolla pinnata* can be taken into consideration as a tool for wastewater treatment from agriculture activities especially suitable wastewater treatment for small poultry farming.

Keywords *Azolla pinnata*, phytoremediation, poultry industry wastewater, soil fertility

INTRODUCTION

The poultry industry is one of the largest and fastest growing agro-based industries in the world. There is an increasing demand for poultry meat mainly due to its acceptance by most societies and its relatively low cholesterol content. The poultry industry is currently facing a number of environmental problems. One of the major problems is the accumulation of large amount of wastes, especially manure and litter, generated by intensive production. The accumulation of these wastes may pose disposal and pollution problems unless environmentally and economically sustainable management technologies are evolved (Bolan et al., 1992). The poultry industry should mitigate environmental consequences associated with air and water quality parameters that are impacted. Therefore, the development of cost-effective technologies for wastewater treatment should be studied.

Azolla, a genus of floating aquatic ferns is distributed throughout tropical and temperate regions of the world (Kitoh et al., 1993). Azolla possesses the ability to utilize atmospheric N_2 due to a symbiosis with the blue-green alga *Anabaena Azollae*, which grows in the cavities of Azolla leaflets. Azolla has been used extensively and effectively for green manure in rice fields instead of chemical fertilizer in Asia. Interest in the use of this plant as a biological filter for the renovation of waste water has increased (Watanabe et al., 1992). Nowadays, poultry production in Thailand has increased and made the treatment of its waste and wastewater an urgent environmental issue. *Azolla pinnata* was chosen as an aquatic plant for the wastewater treatment because of its effeicency in removing organic and nutrient wastes and because the biomass can be used for improves soil fertility.

OBJECTIVES

The objectives of this study were to test the role of *Azolla pinnata* in poultry wastewater treatment and increased soil fertility for sustainable soil resources.

MATERIALS AND METHODS

Test organism

Azolla pinnata used in our experiments was successful cultured under control laboratory conditions at the Ecotoxicology and Environmental Sciences Laboratory, Faculty of Agriculture, Khon Kaen University, Thailand.

Experiment

The experiment was conducted in 2008 using *Azolla pinnata* to treat the wastewater and ran for a 7-d period. Water samples from the poultry industry were collected and analyzed for water quality parameters following the standard methods for the examination of water and wastewater (APHA 1998). Biomass of *Azolla pinnata* was recorded after experiment (Vermaat, 1998).

Laboratory tests were performed in order to examine the efficiency of using A. pinnata to treat the wastewater from poultry industry. Extensive monitoring of the treatment efficiency was performed by collecting weekly samples from the different treatment units. All physico-chemical analyses for pH, COD, BOD, NPK, TSS, dissolved oxygen were performed according to Standard Methods (APHA, 1998). Each pond made of cement occupied 1 m^2 area and was 0.48 m deep. The experimental ponds were inoculated with A. pinnata, at 60 g fresh aquatic fern per container.

The plant growth rate and yield were monitored after the experiment in each pond. The harvested biomass was drained, weighed and dried in an oven at 70^{o}C. The dry matter content was calculated. The dry matter was powdered in a tissue grinder and 0.2 g was used for organic N analysis. As many as 0.1 g of the powder was taken and burned at 550^{o}C for 1 h. The ash was analysed for phosphorus content using the persulfate digestion method (APHA, 1998) followed by the vanadomolybdate colorimetric method (APHA, 1998).

Statistical analysis

Statistical analysis including calculation of average values, standard deviation (S.D.) and regression was performed on the data obtained in the tests with Microsoft Excel and SPSS 12.0. Test of significance was performed by one-way analysis of variance (ANOVA) by Statistic V8.

RESULTS

The water quality parameters of poutry effluent are shown in Table 1. The results showed that *Azolla pinnata* can reduce BOD of wastewater from slaughter to 41% and produce the biomass of *Azolla pinnata* 90, 167, 245% in 100, 50, 25% dilution of wastewater, respectively (Tables 2 and 3).

Table 1 Selected water quality of poultry wastewater effluent

Parameter	Source of water	
	Leachate from chicken manure	Wastewater from slaughter
pH	7.3	7.7
EC (ms/cm)	2.3	1.5
BOD (mg/L)	500	1450
Oil & Grease (mg/L)	0.16	0.12
TKN (mg/L)	63	70
TP (mg/L)	6.48	6.89
SS (mg/L)	20	20
TS (mg/L)	4600	1140
TDS (mg/L)	4580	1120

Table 2 Potential of using A. pinnata for poultry wastewater treatment in BOD reduction

Water Treatment	BOD (mg/L) Before	After	% Change of BOD
Leachate from chicken manure	500±50	400±70	-20%
Leachate from chicken manure +*A. pinnata*	500±50	850±25	+70%
Wastewater from slaughter	1450±50	1050±100	-27.5%
Wastewater from slaughter +*A. pinnata*	1450±50	850±50	-41.37%

Value are mean ± standard deviation. Mean with the same letter in the column are not significantly different (P>0.05). [a] values are means ± standard deviations (n = 3).

Table 3 Biomass production of *A. pinnata* after poultry wastewater treatment

Leachate from chicken maure	Biomass Before	After	Biomass production (%)
100%	40 cell	0 cell	0
50%	40 cell	13 cell	0
25%	40 cell	18 cell	0
Leachate from slaughter	**Biomass Before**	**After**	**Biomass production (%)**
100%	40 cell	76 cell	90%
50%	40 cell	107 cell	167%
25%	40 cell	138 cell	245%

Table 4 Biomass production and nutrient (%K, %P and %N) of *A. pinnata* in waste water treatment

Treatment	%K	%P	%N	% Biomass production
Control	4.63	0.75	2.66	142.67
Azolla in 100	2.43	0.57	1.98	0
Azolla in 50	3.45	1.29	2.50	45.10
Azolla in 25	8.92	0.75	3.51	150.33

Table 5 Potential of using A. pinnata for slaughter wastewater treatment in BOD reduction after 1, 2, and 3 weeks

Treatment	Week 0	Week 1	Week 2	Week 3	% BOD Reduction
100	1325.0 A	1300.0 A	1275.0 A	1325.0 A	30%
100+azola	1325.0 A	1225.0 A	1225.0 A	1225.0 B	27.54%
50	641.67 B	675.00 B	650.00 B	655.00 C	3.06%
50+azola	641.67 B	416.67 C	408.33 C	383.33 D	40.25%
25	416.67 B	350.00 CD	350.00 CD	375.00 D	10.01%
25+azola	416.67 B	266.67 D	241.67 D	233.33 E	44.01%
CV	17.39	8.39	7.48	3.15	
t-test	**	**	**	**	

Value are mean ± standard deviation. Mean with the same letter in the column are not significantly different (P>0.05). [a] values are mean ± standard deviations (n = 3).

From Table 5, the use of *A. pinnata* in wastewater could reduce BOD values compared with control with a significant difference (p< 0.01) in each treatments. BOD values were reduced within the first week and more reduced in Week 3. The use of Azolla in the treatment of wastewater from a chicken farm, 25% and 50% can reduce BOD up to 44% and 40%, respectively**.** From Table 6, the use of *A. pinnata* in wastewater could reduced COD values compared with controla significantly difference (p< 0.01) in each treatment. COD values were significantly reduced in week 3 espectially in wastewater 50% could reduce the COD value at most 87.5%.

Table 6 Potential of using A. pinnata for slaughter wastewater treatment in COD reduction after 1, 2, and 3 weeks

Treatment	Week 0	Week 1	Week 2	Week 3	% COD Reduction
100	5200.0 A	3900.0 A	2925.0 A	3900.0 A	25.00%
100+azola	5200.0 A	2275.0 B	1408.3 B	2816.7 B	45.84%
50	2600.0 B	1950.0 B	812.50 C	1137.5 C	12.50%
50+azola	2600.0 B	845.00 C	715.00 CD	715.00 CD	87.50%*
25	1040.0 C	758.33 C	595.83 CD	595.83 D	31.25%
25+azola	1040.0 C	563.33 C	303.33 D	281.67 D	72.92%
CV	27.9	22.53	26.21	19.47	
t-test	**	**	**	**	

Values are mean ± standard deviation. Mean with the same letter in the column are not significantly different (P>0.05). [a] values are means ± standard deviations (n = 3).

CONCLUSIONS

This study showed that *Azolla pinnata* was suitable for the wastewater treatment from chicken industry especially from the slaughter. The results found that *Azolla pinnata* can reduce BOD and COD in wastewater from slaughter and produce the biomass of *Azolla pinnata*. As the wastewater associated high amount of nutrient in experimental can increase the *Azolla pinnata* biomass and accumulate the nutrient. Therefore, biomass can be used for agriculture land to improve soil fertility.

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