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Effect of Storage on Nutrient Stability in Algal Pond Effluent

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Abstract: This study was conducted to investigate the possible changes in the composition of effluent in relation to its nutrient stability during storage and its ability to supply plant available nutrients. The samples collected from high rate algal ponds (HRAP) were stored with the aim of storage effect on nutrient stability in the algal pond effluent. The trend of change in the chemical composition of algal pond effluent suggested that it can be stored for a week at 2°C with only minor changes in ammonium, nitrite, nitrate, phosphate and potassium during storage. Fresh or stored samples can be applied to the pot experiments but their analysis prior to each application will be essential.

Key words: Nutrient stability, algal pond effluent

Introduction

Problems of the disposal of agricultural effluents most frequently concern pig slurry because herd size need not to be related to the area of land available for disposal. The search for alternative disposal systems has been stimulated by the cost of disposal, concern over environmental effects and possible soil and plant nutrition problems associated with heavy or in appropriately timed slurry spreading.

Aerobic treatment whilst lowering the organic matter content and offering a method to control odour still results in an effluent rich in nitrogen and phosphorus which may restrict its disposal to land during certain times of the year (Groeneweg and Seeder, 1985). Svoboda and Fallowfield (1989) stored the aerobically treated slurry in settling tanks. Settled sludge was discharged to the farm slurry storage tank for subsequent field spraying. Fallowfield (1987) reported that HRAP's, where algal photosynthesis is optimised, are more efficient than waste stabilization ponds in terms of land area and retention times required to achieve satisfactory effluent. Plaixats *et al*. (1988) analyzed piggery waster, effluent residue and supernatant for their properties and chemical composition. Large quantities of mineralizable or available nutrients were found in the effluent after anaerobic digestion. They recommended that the effluents are better for agricultural use as fertilizer than undigested pig excreta. The storage samples of algal pond effluent were to be applied to the pot experiment.

Materials and Methods

This experiment was conducted in the Department of AFE, University of Glasgow during 1993. The samples of algal pond effluent were collected from small scale 2m^2 surface area, high rate algal ponds run be the Department of Biochemistry of the Scottish Agricultural College under controlled conditions in the green house at Auchincruive, Ayr. The samples were stored in the cold room at 2°C. Hydrochloric acid (0.01 M) 0.05M H_2SO_4 and 0.05 M sodium sulphate were prepared. Water was also used as extractant. Sodium sulphate was purified from ammonium impurities (Khan, 1987), Filter papers used in the filtration were washed (Shah, 1988).

The algal pond effluent was extracted with four extractant along with direct filtrate of the effluent. The stock of the algal pond effluent was stirred using a magnetic stirrer. Ten g of algal pond effluent was weighed into 100 ml plastic bottles using four replications and blanks for each treatment. Ninety ml of each extractant was added to these bottles. The blank bottles contained 100 ml of the extractant. The bottles were tightly capped and were shaken for one hour on an end-over-end shaker at room temperature. The solutions were then filtered through washed whatman No. I filter papers. The filtrate was collected into 100 ml plastic bottles and stored at 2°C until analysis. Ammonium nitrate, nitrite and phosphate was determined by using Technicon AutoAnalyzer-II. Ammonium was determined by the method of Brown (1973). Nitrate and nitrite were measured by the method. Phosphate was measured by the method based on the formation of a phospho-molybdate complex which is reduced by ascorbic acid to give a blue colour measured at 880 nm. The potassium was determined by using a corning EEL flame photometer.

The stock of algal pond effluent in a five litre container was stored at 2°C in the cold room. The required portion out of it was brought into the laboratory weekly, filtered and analysed for plant available nutrients. A 0.1M HCl extract of this effluent was also obtained at the same time. Nitrite and nitrate were determined from the filtrate while the ammonium, phosphate and potassium were measured in 0.1 M HCl extracts. The analytical conditions for nutrient stability are given in Table 1.

Results and Discussion

The results are shown in Table 2. It was difficult to bring fresh samples of algal pond effluent from the Scottish Agricultural College, Auchincruive, Ayr, prior to each application to the pot experiment to be conducted. It was, therefore, desirable to store the treated effluent in the cold room at 2°C before each application. As the treated effluent was to be stored, it was imperative to test nutrient stability during storage.

The results shown in Table 2 reveal that there are significant changes in ammonium and phosphate content of the effluent. There are also variations in nitrite and nitrate levels although statistics could not be applied due to

Table 1: Analytical conditions for nutrients stability

Nutrients	Dilution (ml)	Standard (mg l^{-1})	Samples per hour	Filtration and extraction
Ammonium-N	1:10	0-10	40	0.1M HCL
Nitrite-N	1:50	0-1	40	Filtrate
Nitrate-N	1:50	0-1	40	Filtrate
Phosphate	-	0-5	40	0.1M HCL
Potassium	-	0-8	-	0.1M HCL

insufficient replications. Potassium levels in the effluent showed no significant change. The trend ofchange in the chemical composition of algal pond effluent suggests that it can be stored for a week at 2°C with only minor changes in ammonium, nitrite, nitrate, phosphate and potassium during storage. Fresh or stored samples can be applied to the pot experiment but their analysis prior to each application will be essential. These results are in conformity with the findings of Groeneweg and Seeder (1985) who reported that aerobic treatment whilst lowering the organic matter content and offering a method to control odour still results in an effluent rich in nitrogen and phosphorus. There is similarity in between the results of the present study and results reported by Plaixats *et al*. (1988) who found large quantities of mineralizable or available nutrients in the effluent after anaerobic digestion. They also recommended the effluent for agricultural use as fertilizer.

Table 2: Effect of storage on the chemical composition of algal pond effluent

Nutrients	Storage (Weeks)		
	0	1	2
Ammonium-N	25.8a	28.8a	29.9b
Nitrite-N	5.5*	6.4	5.3
Nitrate-N	42.6*	49.7	45.7
Phosphate	15.3a	14.5b	16.0
Potassium	59.2*	57.8a	57.8

Figures in a column with the same letters following are not significantly different at 5% level using a Fisher's LSD Test. *ANOVA could not be applied because of insufficient replicates.

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