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# NUTRIENT RELEASE CHARACTERISTICS OF DUCK MANURE I. EFFECT OF DIET, BEDDING MATERIALS AND MANURE STORAGE

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## Abstract

The cumulative ammonia-N release from fresh manure of low or high grade diet with or without rice husk, varied between a minimum of 6.5 and a maximum of 9.2 mg/g dry matter and the soluble reactive phosphorus (SRP) release was between 1.7 and 2.0 mg/g dry matter. The cumulative ammonia-N release from 4-week-old low or high grade manure stored with or without rice husk, varied between 7.0 and 9.1 mg/g dry matter and the SRP release varied from 2.2 to 4.1 mg/g dry matter. Nearly all soluble nitrogen and phosphorus were released on the 4th day of manure application. The rate of nutrient release was increased by the improved diet manure and proper management of manure. Use of bedding material caused a reduction of the amount of nutrient release on a per unit weight basis.

## Introduction

The potential for recycling animal wastes into fish biomass has bee demonstrated by the Chinese who use animal nanure as the main fertilizer in. fish culture. Most farms undertake animal husbandry to supply fertilizer for fish farming (1).

The rationale for using animal manure as fertilizer for fish production becomes apparent when it is realized that about 72-79% of the nitrogen, 61-87% of the phosphorus and 82-92% of the potassium in feed ration fed to animals are recovered in their excreta. Thus, the amount of nutrients excreted by an animal during a one year course can be considerable. However, the amount and composition of the wastes excreted by animal per unit time varies with the total live weight of the animal, the species, the age, the feed and water intake, the climate and the management (2).

It is still not understood how much nutrition is derived by fish from the wastes themselves and from the natural food in ponds which develops as a result of the nutrient release from wastes. The present work was thus aimed at assessing the rate of nitrogen and phosphorus release from duck manure as a function of time with respect to duck diet, storage and management of manure.

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## Materials and Methods

The experiments were cunducted in 15 concrete tanks of 4 $m^2$ size. A one meter identical depth was maintained throughout the experiment. The experimental design was a randomly arranged factorial one. The nutrient release experiment was carried out by short experiments of 7 days duration in the concrete tanks. A control with no inputs was conducted to account for nitrogen plus phosphorus in water not due to manure. The three experiments were as follows :

*Expt. 1A* (fresh manure). Manure collected for 24 h was regarded as fresh and applied to tanks within one h. Fresh manures were collected twice a week from ducks fed low (M1) and high (M2) grade diets by putting corrugated galvanized steel tray under duck cages. The low grade diet contained 10.4% crude protein and 25% clean rice-husks while the high grade diet contained 16.9% crude protein and 5% clean rice-husks. Both types of manures were used with and without rice husks as bedding materials.

*Expt. IB* (stored manure, low grade). Manure from low grade diet (M1) was stored for 4 weeks under a shed and half amount was mixed with equal amount of rice husks and rest without rice husks. Each lot again was divided into sub-samples. One sub-sample was sprayed over a tray into a thin layer for exposing to air and was covered with a net to prevent contamination. The other sub-sample was kept in a plastic bag tied at the mouth with a straw being inserted for the release of the gases.

*Expt. 1C* (stored manure, high grade). Manure from high grade diet (M2) was stored for 4 weeks as in 1B. During manure storage, the average maximum temperature varied between 32.1 and 34.6°C and the minimum temperature between 22.4 and 23.7°C.

Each type of manure was soaked with sufficient water and stirred with a pre-rinsed bamboo piece and was applied by mixing with water and sprayed over at rates of 200, 400 and 600 kg dry matter/ha/week, respectively. The tanks were covered with GI corrugated sheets to prevent algal growth. Water samples were collected daily for 7 days after application of the manures and analyzed for ammonia-N, soluble reactive phosphorus (SRP) and alkalinity. *In situ* determinations of pH, dissolved oxygen (DO) and temperature were made at the time of water sample collection.

*Analytical methods.* Duck manure and duck feed were analyzed for dry matter by drying a homogenous sample in oven at 80°C for 48 h. Organic carbon was determined by rapid wet oxidation method by chromic acid (3) total

Kjeldahl nitrogen by alkali distillation and total phosphorus as described in IRRI (4).

Besides, ash content of diet was determined by ignition in a muffle furnace at 500-600°C for 6 h (5); crude fibre by acid-base digestion (5); crude lipid by extracting with petroleum ether; neutal detergent fibre (NDF) by digestion with neutral detergent solution; acid detergent fibre (ADF) by digestion with acid detergent solution; cellulose by treating the ADF residue with 72% sulfuric acid (5); lignin by igniting the cellulose residue at 450°C for 3h in a muffle furnace; hemicellulose was calculated by difference between NDF and ADF.

Total alkalinity of water samples was determined by titration with 0.02N sulfuric acid using methyl orange indicator (6); SRP was determined colorimetrically following the method as described by Jackson (7).

All data presented in the Tables are averages of three individual replicates. The data were subjected to statistical analyses.

## Results and Discussion

The chemical compositions of the duck diets and duck manures are shown in Tables 1 and 2 respectively.

**Table 1. Chemical composition of duck diets (per 100 g d. m.) .**

| Composition | Type | |
|---|---|---|
| | High grade (%) | Low Grade (%) |
| Moisture | 9.6 | 8.9 |
| Crude Protein | 16.9 | 10.4 |
| ME (MJ/kg dry matter*) | 12.2 | 10.9 |
| Crude Lipid | 6.7 | 6.5 |
| Crude Fibre | 6.0 | 13.4 |
| Ash | 7.2 | 8.8 |
| NDF | 20.6 | 29.2 |
| ADF | 7.7 | 17.6 |
| Hemicellulose | 13.0 | 11.6 |
| Cellulose | 3.9 | 9.4 |
| Lignin | 2.8 | 4.4 |
| Nitrogen | 2.7 | 1.6 |
| Phosphorus | 0.7 | 1.5 |

* Calculated

Fresh manure from duck fed either of the diets contained 17% to 18% dry matter, while the 4 week old manure contained 80 to 90% dry matter when stored aerobically and 23 to 24% dry matter when stored anaerobically (Table 2). The total N and P contents were always higher in manures obtained from high diets whether the manures were fresh or 4 weeks old or whether they were stored aerobically or anaerobically with or without bedding materials (Table 2). There were little variations in the organic carbon contents.

**Table 2. Chemical composition of duck manure.**

| Type of manure | | | | D. M. (%) | N (%) | P (%) | N:P | O.C. (%) |
|---|---|---|---|---|---|---|---|---|
| Fresh : | | | | | | | | |
| | M1 + RH | | | 17.9 (0.6) | 2.9 (0.2) | 1.4 (0.1) | 2.0 | 40.8 (0.2) |
| | M1 – RH | | | 17.2 (0.0) | 3.2 (0.2) | 1.6 (0.2) | 2.0 | 39.4 (0.2) |
| | M2 + RH | | | 18.4 (0.0) | 4.2 (0.3) | 1.5 (0.2) | 2.8 | 36.4 (0.2) |
| | M2 – RH | | | 17.8 (0.1) | 4.4 (0.1) | 1.7 (0.1) | 2.6 | 38.7 (0.1) |
| 4 week old : | | | | | | | | |
| M1 | + | RH | + O2 | 91.3 (0.3) | 0.8 (0.1) | 0.7 (0.1) | 1.2 | 38.5 (0.3) |
| | + | RH | – O2 | 23.2 (0.2) | 2.6 (0.1) | 0.8 (0.1) | 3.2 | 39.4 (0.2) |
| | – | RH | + O2 | 78.6 (0.6) | 1.2 (0.1) | 0.9 (0.1) | 1.3 | 37.6 (0.1) |
| | – | RH | – O2 | 23.6 (0.2) | 3.0 (0.1) | 1.2 (0.1) | 2.5 | 38.6 (0.2) |
| M2 | + | RH | + O2 | 93.3 (0.3) | 0.9 (0.1) | 1.4 (0.1) | 0.6 | 36.6 (0.2) |
| | + | RH | – O2 | 24.3 (0.2 | 3.2 (0.2) | 1.6 (0.1) | 2.0 | 38.2 (0.2) |
| | – | RH | + O2 | 79.4 (0.2) | 1.2 (O.1) | 1.9 (0.1) | 0.6 | 39.6 (0.4) |
| | – | RH | – O2 | 23.2 (0.2) | 3.5 (0.1) | 2.2 (0.1) | 1.6 | 38.4 (0.4) |

Figures in parentheses are the S. E. at ±1; +RH manure stored with rice husk and – RH without rice husk; +O2 aerobic, – O2 anaerobic

The ammonia-N and SRP contents in control tanks in Expt. 1A (fresh manure) varied from 0.06 to 0.15 mg/l and 0.02 to 0.03 mg/l respectively. In Expt. 1B (4 week old, low grade) the corresponding values were 0.04 to 0.16 mg/l and 0.03 to 0.04 mg/l respectively while the same in Expt. 1C (4 week old, high grade) were 0.08 to 0.12 mg/l and 0.02 to 0.03 mg/l.

Cumulative ammonia-N from fresh duck manure (Expt. 1A) was found significantly higher than 4-week old manures, the values being in the ranges between 3.0 to 9.0 mg/g dry matter. The cumulative ammonia-N release from 4-week-old manure (Expt. 1B) of low grade diet was significantly lower than fresh and high grade diet manure. The values ranged between 2 and 8 mg/g dry matter. The cumulative ammonia-N release from manure of high grade diet (Expt 1C)

was found to be significantly higher than that observed in Expt. 1B, the values being in the ranges of 3 to 9 mg/g dry matter (Fig 1, a-c).

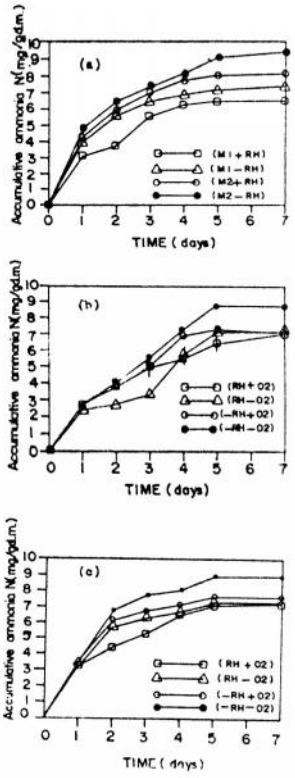


Fig. 1. Accumulation of ammonia-N from various types of duck manure as a function of time. (a) fresh manure; (b) low grade manure; (c) high grade manure.

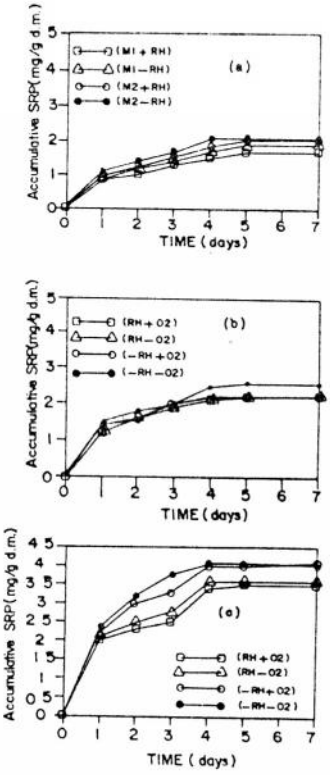


Fig. 2. Accumulation of SRP from various types of duck manure as a function of time (a) fresh manure; (b) low grade manure; (c) high grade manure.

The cumulative SRP release in Expt. 1C showed significant difference from either Expt. 1A or 1B. The values ranged between 0.9 and 2.0, 1.2 and 2.6 and 2.0 and 4.1 mg/g dry matter for Expt. 1A, Expt.1B and Expt. 1C respectively (Fig. 2, a-c)

The cumulative ammonia-N and SRP releases on day 4 in the various experiments were statistically analyzed for significant diference at $p<0.05$ (Table 3) as there was no appreciable release beyond this period. The ammonia-

N values of treatment 4 in Expt. 1A and 1B were significantly greater than treatmetns 1, 2 or 3. In Expt. 1C, treatment 1 was signifcantly different from treatment 2 and treatment 3 was significantly different from treatment 4. The SRP release in Expt. 1A for treatment 1 was significantly higher than treatments 2, 3 or 4. In Expt. 1B, though there were no significant difference for the values between treatments 1 and 2 or between treatments 3 and 4, there was however, significant difference between the two sets of treatments i. e., between 1 and 2 and 3 and 4. Similar observations were made for the treatments in Expt. 1C also.

**Table 3. Summary of the cumulative mean ammonia-N and SRP (mg/g DM) released on day 4 from different types of duck manure (±1 S. E.) .**

| Type of Manure | Nutrient | Treatment | | | |
|---|---|---|---|---|---|
| | | 1 (M1 + RH) | 2 (M2—RH) | 3 (M2+RH | 4 (M2—RH) |
| Fresh | Ammonia-N | 6.5 (0.06) a | 7.2 (0.12) b | 8.1 (0.12) c | 9.2 (0.12) d |
| | SRP | 1.7 (0.03) a | 1.9 (0.03) b | 2.0 (0.03) b | 2.0 (0.03) b |
| | | 1 (RH+02) | 2 (RH—02) | 3 (—RH+02) | 4 (—RH—02) |
| 4 wk old manure low grade | Ammonia-N | 6.5 (0.80) a | 7.1 (0.20) a | 7.3 (0.06) a | 8.8 (0.12) b |
| | SRP | 2.2 (0.09) a | 2.2 (0.12) a | 2.5 (0.06 b | 2.6 (0.12) b |
| | | 1 (RH+02) | 2 (RH—02) | 3 (—RH+02) | 4 (—RH—02) |
| 4 wk old manure high grade | Ammonia-N | 7.1 (0.06) a | 7.3 (0.07) b | 7.7 (0.07) c | 9.1 (0.07) d |
| | SRP | 3.5 (0.03) a | 3.6 (0.10) a | 4.0 (0.09) b | 4.1 (0.03) b |

Values having the same alphabet (subscripts) are not significantly different at p (0.05). M1, M2, RH, $O_2$ are same as in Table 2.

It was noted that with higher loading rate of manure, the nutrient concentration in water was increased but in terms of unit weight of dry matter, the nutrient concentration showed no difference between lower and higher loading rate.

*Water quality*. There were no singnificant differences between treatments as regards dissolved oxygen (DO) and pH. The DO varied between 0.5 and 5.0 mg/1,

1.0 and 4.0 mg/1 and 1.5 and 5 mg/1 in Expts. 1A, 1B and 1C respectively. The pH varied between 7.5 to 8.2 in the three experiments. The variation in total alkalinity in Expt. 1 was between 287 to 362 mg $CaCO_3$/1 as against the control of 300-337 mg $CaCO_3$/1. The same for Expt. 1B was 336 to 385 mg $CaCO_3$/1 as against 300-345 mg $CaCO_3$/1 for control. The total alkalinity in Expt. 1C varied between 288 and 359 mg $CaCO_3$/1 whereas the values for control were between 294 and 335 mg $CaCO_3$/1.

## Discussion

It is apparent from present study that singificant amounts of soluble nitrogen and phosphorus are released into water. Only 20 to 30% of the total nitrogen present in the manure comes to the solution as ammonia. The major portion possibly remains in the complex organic form. Similarly, only about 20% of the total phosphorus in the manure becomes available. The amounts of soluble nitrogen and phosphorus were however, greater from manures obtained from ducks fed with high grade diets. It was also apparent that almost all the soluble nitrogen and phosphorus were released by 4 to 5 days after application of the manures indicating that frequency of manure application should be limited within this period.

Open storage reduces the nutrient release per unit weight basis because the major part is lost through volatilization. Use of bedding materials as rice husk dilutes the manure, thereby reducing the nutrient release per unit dry matter.

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