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# Use of redworms (*Perionyx excavatus*) to manage agricultural wastes and supply valuable feed for poultry

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# Introduction

# Redworms
(*Perionyx excavatus*)

**Vermicompost:**

- Stabilized humus-like products
- Nutrients for plant (N, P, K)
- Low levels of contaminants
- Less impact the environment

**Fertilizer**

**Vermiprotein:**

- 50–75% protein (DM)
- 7–10% fat (DM)
- Essential amino acid
- Vitamins (B1, B3,B12, B6)
- Minerals (Ca, P, Fe)

**Animal feed**

# Materials and methods

## Experiment 1. Vermicompost and worm growth

| Materials (%) | Treatment 1 (fresh) | Treatment 2 (composted) | Treatment 3 (composted) | Treatment 4 (composted) |
|---|---|---|---|---|
| **Cattle manure** | **100** | **50** | **50** | 0 |
| **Pig manure** | 0 | **50** | **40** | **90** |
| **Rice straw** | 0 | 0 | **10** | **10** |
| **Worms** | | | | |
| **Replicates** | **4** | **4** | **4** | **4** |
| **Initial weight, g** | **500** | **500** | **500** | **500** |
| **Days of Composting** | **45** | **45** | **45** | **45** |

## Chemical analysis of substrate and vermicompost

- **Total N**: were measured by Kjeldahl method: $H_2SO_4$, d=1.84 + $C_6H_4(COOH)(OH)$ + (copper sulphate + selenium, potassium sulphate)
- **Total P**: Perchloric acid ($HCLO_4$ 70%), colorimetric method based on vanadomolybdate
- **Some exchangeable cations in an extract (K, Na and Mg)**: the technique of flame atomic emission spectrophotometry
- **$NH_4^+$**: Nessler ($K_2HgI_4$)
- **$NO_3^-$**: Cataldo method

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## Experiment 2. Feeding Chicken with worms

- **Chickens**: 148 heads of broiler (Ho x Luong Phuong) 4 - 10 wk of age were divided into 3 experimental groups and 1 control one
- **Basic diets**: Based on commercial feed, maize, rice bran/starched rice. Two diets: 19% protein, 5% fat (22 to 42 days of age) and 16% protein, 6% fat (43 to 70 days of age) (NRC guidelines)
- **Worms**: Supplemented with 1; 1.5 and 2 % on DM of basic diet by fresh form
- Chicken access ad libitum to feed and water

## Measurement on chicken

- **Average body weight (g) and feed intake (kg)** were calculated at 4, 5, 6, 7, 8, 9 and 10 wk of age from pen data
- **Carcass yield**: Chickens were slaughtered and carcass yield (deboned breast, thigh, abdominal fat, etc) were recorded
- **Meat quality**: Breast muscles were removed from the carcass at 30 min post-mortem and stored at 2-4°C

✓ **$pH_{12}$; $pH_{72}$** : by pH meter (Model 240)

✓ **Color (L*, a*, b*)**: colorimeter (Model CR-200), C.I.E. 1978

✓ **Drip loss**: percentage of moisture loss during storage (2-4°C )

✓ **Cooking loss**: percentage of weight loss after cooking on aluminum trays at $85^0$C for 45 minutes in steam

# Results and discussion

# Table 1. Worm biomass gain and growth rate

| Parameters | Treatment 1 | Treatment 2 | Treatment 3 | Treatment 4 |
|---|---|---|---|---|
| Initial weight, g | 500 | 500 | 500 | 500 |
| Finished weight, g | 1213 | 937 | 750 | 700 |
| Net weight gained, g | 713 ± 12.6$^{a}$ | 437 ± 37.5$^{ab}$ | 250 ± 61.2$^{b}$ | 200 ± 61.2$^{b}$ |
| Growth rate, % | 242.6 | 187.4 | 150 | 140 |

*Mean values followed by different letters are statiscally different (ANOVA, Duncan multiple-ranged test; P < 0.05)*

## Table 2. Chemical composition of fresh/composted substrates (FS/CS) and vermicompost (VC)

| Para meters | Fresh Pig Manure | Treatment 1 | | Treatment 2 | | Treatment 3 | | Treatment 4 | |
|---|---|---|---|---|---|---|---|---|---|
| | | FS | VC | CS | VC | CS | VC | CS | VC |
| DM, % | 33.9 | 19.2 | 23.0 | 30.0 | 32.9 | 34.2 | 28.4 | 38.0 | 31.3 |
| N, % | 1.87 | 1.73 | 1.55 | 1.83 | 1.01 | 1.54 | 1.24 | 1.34 | 1.05 |
| P, % | 1.01 | 0.84 | 1.25 | 0.83 | 1.13 | 0.87 | 1.20 | 0.86 | 1.46 |
| K, % | 0.57 | 0.63 | 0.83 | 0.56 | 0.67 | 0.52 | 0.61 | 0.43 | 0.66 |
| Ca, % | 1.24 | 0.89 | 1.60 | 1.15 | 1.66 | 0.95 | 1.74 | 1.27 | 1.92 |
| Mg, % | 0.77 | 0.59 | 0.77 | 0.72 | 0.71 | 0.66 | 0.75 | 0.67 | 0.80 |
| $NO_3^-$, mg/kg | 41.45 | 84.52 | 124 | ***16.67*** | ***791*** | 20.6 | 236 | 16.6 | 224 |
| $NH_3$, mg/kg | 3293 | 975 | 107 | 597 | 561 | 115 | 64.9 | 133 | 55.1 |
| $NH_4^+$, mg/kg | 4234 | 1254 | 137 | 768 | 83.7 | 148 | 83.44 | 171 | 70.8 |

## Table 3. Body weight of chickens at different weeks of age (g/head, Mean ± SEm, n=37)

| Week of age | Control | Group 1 (1% worms) | Group 2 (1.5 % worms) | Group 3 (2% worms) |
|---|---|---|---|---|
| 4 | 530 ± 19.0 | 520 ± 18.1 | 526 ± 16.6 | 528 ± 17.4 |
| 5 | 700 ± 18.0 | 699 ± 18.0 | 697 ± 16.9 | 707 ± 16.0 |
| 6 | 894 ± 18.7 | 893 ± 18.0 | 916 ± 17.6 | 925 ± 19.2 |
| 7 | 1115 ± 18.2 | 1125 ± 24.5 | 1131 ± 19.9 | 1166 ± 21.1 |
| 8 | 1348 ± 19.9 | 1378 ± 22.6 | 1382 ± 22.6 | 1408 ± 27.4 |
| 9 | 1590 ± 17.7$^{a}$ | 1638 ± 19.5$^{ab}$ | 1649 ± 24.2$^{ab}$ | 1684 ± 30.7$^{b}$ |
| 10 | 1823 ± 20.0$^{a}$ | 1842 ± 17.9$^{ab}$ | 1911 ± 19.0$^{ab}$ | 1925 ± 36.2$^{b}$ |

***Mean values followed by different letters are statistically different (ANOVA, Duncan multiple-ranged test; P < 0.05)***

# Table 4. Feed conversion efficiency (kg)

| Week of age | Control | Group 1 (1% worms) | Group 2 (1.5 % worms) | Group 3 (2% worms) |
|---|---|---|---|---|
| 5 | 2.60 | 2.52 | 2.65 | 2.59 |
| 6 | 2.65 | 2.68 | 2.72 | 2.78 |
| 7 | 3.03 | 3.06 | 2.89 | 2.87 |
| 8 | 3.20 | 3.23 | 3.05 | 2.93 |
| 9 | 3.52 | 3.50 | 3.13 | 3.10 |
| 10 | 3.97 | 3.94 | 3.69 | 3.41 |
| Average | **3.16** | 3.16 | 3.02 | **2.95** |

# Table 5. Carcass yield of chicken

| Parameters (%) | Control | Group 1 (1% worms) | Group 2 (1.5 % worms) | Group 3 (2% worms) |
|---|---|---|---|---|
| Carcass | 68.1 | 67.7 | 68.3 | 69.9 |
| Thigh meat | 21.0 | 21.5 | 22.0 | **22.9** |
| Breast meat | 17.2 | 17.1 | 18.1 | **19.4** |
| Abdominal fat | 4.4 | 4.3 | 4.0 | 4.5 |
| Eatable internal organs | 8.8 | 9.2 | 9.6 | 8.8 |

# Table 6. Breast meat quality at 12h postmortem

| Parameters | Control | Group 1 (1% worms) | Group 2 (1.5 % worms) | Group 3 (2% worms) |
|---|---|---|---|---|
| $pH_{12}$ | 5.65 ± 0.02 | 5.62 ± 0.02 | 5.62 ± 0.20 | 5.58 ± 0.01 |
| Drip loss, % | 2.04 ± 0.07 | 2.17 ± 0.14 | 2.11 ± 0.03 | 2.04 ± 0.07 |
| Cooking loss, % | 23.9 ± 0.30 | 23.9 ± 0.22 | 23.0 ± 0.43 | 22.7 ± 0.23 |
| $L^*$(lightness) | 57.1± 0.12 *(57.3 ± 0.25)* | 57.2 ± 0.10 *(57.2 ± 0.42)* | 57.5 ± 0.15 *(57.5 ± 0.14)* | 57.5±0.17 *(57.4 ± 0.34)* |
| $a^*$(Redness) | 8.41± 0.28 *(10.4 ± 0.45)* | 10.3 ± 0.42 *(10.3 ± 0.37)* | 10.3 ± 0.36 *(10.4 ± 0.54)* | 10.2 ± 0.38 *(10.5 ± 0.33)* |
| $b^*$(Yellowness) | 20.9±1.33 *(19.8 ± 0.64)* | 20.0 ± 0.45 *(20.2 ± 0.79)* | 18.6 ± 1.25 *(19.3 ± 0.89)* | 20.7 ± 0.74 *(19.6 ± 0.43)* |

*Meat color values inside the brackets expressed for hen, outside the brackets expressed for cocks*

# Table 7. Breast meat quality at 72h postmortem

| Parameters | Control | Group 1 (1% worms) | Group 2 (1.5 % worms) | Group 3 (2% worms) |
|---|---|---|---|---|
| $pH_{72}$ | 5.68 ± 0.03 | 5.65 ± 0.02 | 5.64 ± 0.02 | 5.62 ± 0.02 |
| Drip loss, % | 2.28 ± 0.04 | 2.26 ± 0.06 | 2.10 ± 0.06 | 2.13 ± 0.05 |
| Cooking loss, % | 25.7 ± 0.55 | 24.7 ± 0.51 | 24.5 ± 0.22 | 25.4 ± 0.51 |
| $L^*$(lightness) | 58.4 ± 0.27 *(58.2 ± 0.21)* | 58.3 ± 0.12 *(58.4 ± 0.27)* | 58.3 ± 0.30 *(58.4 ± 0.16)* | 58.2 ± 0.38 *(58.4 ± 0.44)* |
| $a^*$(Redness) | 8.4 ± 0.28 *(8.0 ± 0.25)* | 9.0 ± 0.29 *(8.5 ± 0.31)* | 9.6 ± 0.28 *(9.0 ± 0.72)* | 8.8 ± 0.31 *(9.3 ± 0.24)* |
| $b^*$(Yellowness) | 19.8 ± 0.52 *(19.3 ± 0.55)* | 17.6 ± 0.92 *(19.3 ± 0.63)* | 17.8 ± 0.53 *(18.8 ± 0.76)* | 19.4 ± 0.69 *(18.1 ± 0.51)* |

*Meat color values inside the brackets expressed for hen, outside the brackets expressed for cocks*

# Conclusions

## Vermiculture:

- Various types of wastes such as cattle and pig manure, rice straw, et… can be used with different ratio for redworm culture
- Feeding worms by 100% of fresh cattle manure resulted in the highest growth rates (net weight gained by 713 g or 243 % in growth rate after 45 days, $P<0.05$)
- Mixtures of cattle and pig manure in 50:50 ratio were also good for worms growth

## Vermicompost:

- Worms can break down efficiently complex organic matters into fertile products called vermicompost which have:

✓Higher nutrients (increase by 0.3 - 0.6% P, 0.1 - 0.2% K and also Ca, Mg) in available and exchangeable forms (NO3-, $NH_4^+$) as compared with initial substrates

✓Lower levels of amoniac ($NH_3$). So, they have less influence on the environment

Supplementing worms in chicken's diets can:

✓Increase the growth rate or body weight, especially with 2% of worms ($P<0.05$)

✓Reduce feed consumption or increases feed conversion efficiency (supplement with 2% reduced 0.21kg per each kg of weight growth or equal to 6.8%)

✓Improve carcass yield without any affecting meat quality (pH, drip and cooking loss, colour) of chicken among groups


**Image 1. Weighting worms**

**An Giang, 16-18 Nov**

**Image 3. Chicken access ad libitum to feed and water**

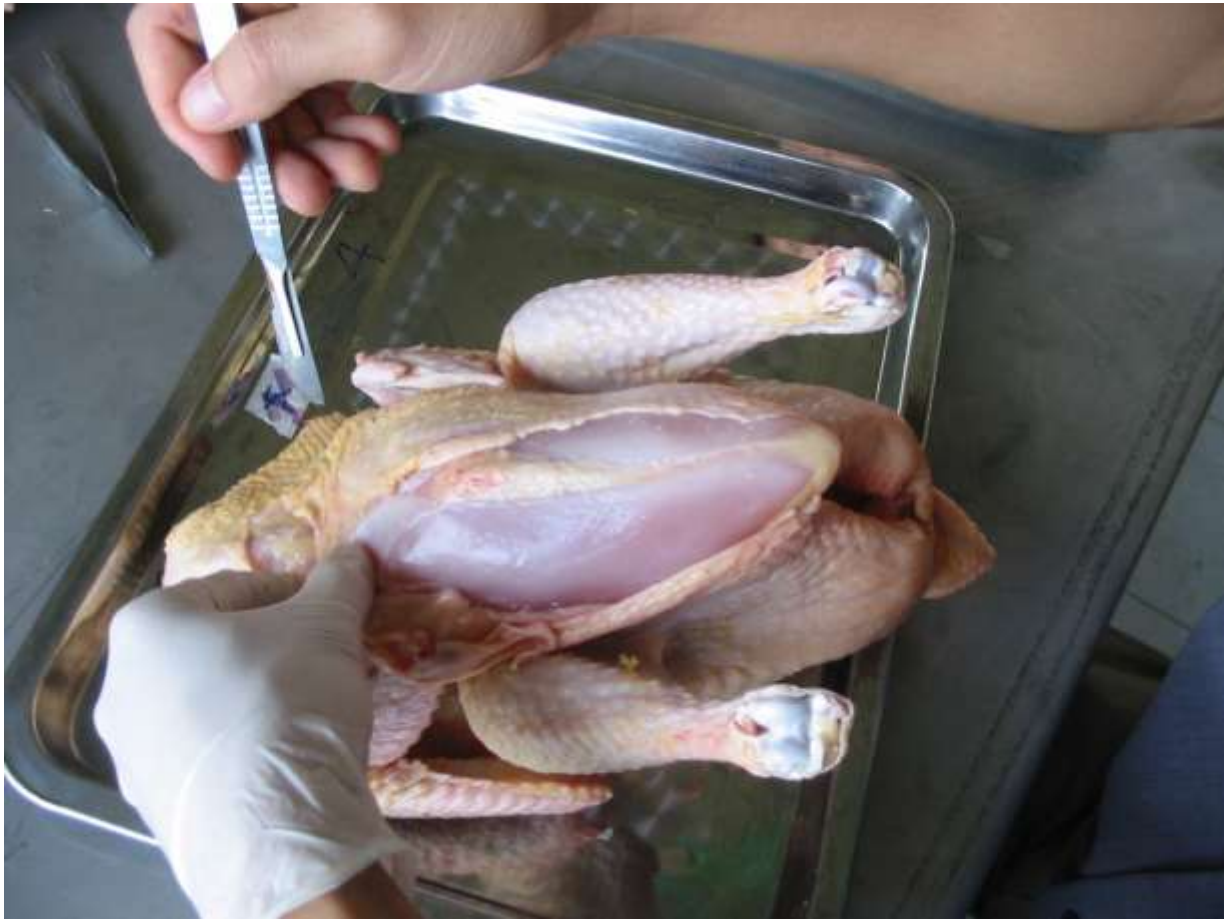

**Image 3. Slaughter and identify carcass characteristics of chicken**

# Thank you for your attention!