Production and utilization of earthworms as feeds for broilers in the Philippines

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Summary

A study on the production of earthworms was conducted using a 50:50 by volume of animal manures in combination with Leucaena leucocephala. *A combination of sawdust, rice hull and rice bran at a proportion of 55, 35 and 10 respectively was also used as a substrate. The earthworms in each box were supplemented with either 0, 100, 200, 300 and 400 g kitchen scraps. On harvesting, hand picking the earthworms from the castings and arranging the contents of the box in a pyramid were tested. Blanching, direct heating, freezing and using an oven-drier were likewise tested on "killing" earthworms prior to drying.*

On broiler utilization, eighty four one-day old broiler chicks were fed with the six rations formulated wherein 6 %, 10 % and 14 % levels of vermimeal and fish meal were used with the commercial mash as the control.

Results revealed that goat manure in combination with Leucaena leucocephala *with 100 to 400 g feed supplement produced the highest gain and largest population. The pyramid method for harvesting and freezing for processing earthworms were found to be the best.*

Commercial broiler mash was significantly better than the home-mixed rations. In the home-mixed rations, 10 to 14 % levels of vermimeal were comparable to 6 % vermimeal and 6 - 10 % fish meal.

Résumé

Une étude sur la production de vers de fumier a été effectuée en utilisant un mélange en parties égales de fumier et de Leucaena leucocephala. *Un mélange de sciure, balles de riz et son de blé dans les proportions de 55, 35 et 10 a également été employé comme milieu nutritif. Des déchets de cuisine à raison de 0, 100, 200, 300 et 400 g par boîte ont été donnés comme supplément.*

A la récolte, on a comparé le triage à la main des vers dans le compost et la disposition du contenu de la boîte en forme de pyramide. De même on a comparé le blanchiment, la chaleur directe, la congélation et la dessication au four pour tuer les vers.

Quatre-vingt quatre poussins d'un jour ont été nourris avec six rations où 6 %, 10 % et 14 % de farine de vers et de farine de poisson ont été employées avec un mélange commercial servant de témoin.

Les résultats obtenus montent que le fumier caprin combiné à L. leucocephala *et 100 - 400 g de complément fournit le meilleur gain et la plus grande population. La méthode de la pyramide pour la récolte et la congélation pour le traitement des vers donnent les meilleurs résultats.*

Le mélange commercial pour poulets de chair a été significativement meilleur que les rations expérimentales où les taux de 10 - 14 % de farine de vers étaient comparables à 6 % de farine de vers et 6 - 10 % de farine de poisson.

Introduction

Earthworm raising was one of the Kilusan as Kaunlaran Projects promoted by the government to uplift the socio-economic status of the Filipinos. Some of the Filipinos ventured in this project, however, most of them had problems on the marketing, processing and utilization of earthworm products and by-products.

On the other hand, the Kilusang Sariling Sikap (KSS) gave emphasis on income generating projects like yellow corn, tilapia and poultry production. These projects can be integrated with earthworm production. In this manner, problems on marketing, processing and utilization of earthworm products and by-products would be reduced. Likewise, the importation of costly feed ingredients for poultry and fishes and fertilizer for plants would be minimized.

The Philippines' poultry industry is largely dependent on protein feedstuffs which are imported at high cost. Likewise due to the scarcity of imported sources of protein and the difficulty of acquiring animal protein feeds from wholesalers, farmers resort in feeding their animals with the available farm by-products which have limited amount and quality of amino acids. Earthworms can solve this problem because these could be raised in their household with minimal management practices.

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Materials and methods

Production, Harvesting and Processing of Earthworms

Fresh manures of cattle, swine, goat and chicken, *Leucaena leucocephala* leaves, sawdust, rice hull and rice bran were piled separately and fermented. Fermentation of substrates was done by keeping them moist and turning them everyday to allow the heat generated to escape from the pile. When there was no more heat generated, an equal proportion of *Leucaena leucocephala* leaves and any of the animal manures were placed in experimental boxes measuring 22' x 16" x 6". A mixture of sawdust, rice hull and rice bran at a proportion of 55, 35 and 10 respectively were placed in separate boxes and served as another substrate. Each box was filled 3/4 of its volume. The boxes were arranged under the shed to protect the worms from direct sunlight, strong rains and predators. Each box was supplemented with either 0, 100, 200, 300 and 400 g fermented kitchen scraps. The species used was *Eudrilus eugeniae* and each box was seeded with 30 earthworms which had approximately the same length and weight and of the same age.

Eudrilus eugeniae (African night crawler) is a native to Western Africa. It is a large worm 5 to 12 inches and a favorite of anglers which is raised as baits in some areas. The back is purplish in color.

The substrates were watered every after third day to maintain moisture. Light was installed and old pieces of newspapers or old sacks were placed on top of the boxes to prevent the escape of the earthworms. The newspapers or old sacks also protected the earthworms from predators and maintained moisture.

Two methods of harvesting earthworms were used. These were turning the substrates and picking by hand the earthworms leaving the substrates in the box. The second method was arranging the contents of the box in a pyramid then separating the earthworm from the castings.

It is necessary to kill earthworms prior to drying because alive earthworms will crawl away when exposed to sunlight. There were four methods tested. The earthworms were blanched at 60°C, freezed overnight, heated in a pan or dried in an over drier at 90°C.

Vermimeal as Substitute to Imported Fish Meal

The earthworms were harvested after 90 days. The large earthworms were then washed three times, allowed to remove the content of their digestive tract for five hours then "killed" by deep freezing. The worms were then dried thoroughly under the sun then ground with the use of a meat grinder. Six rations making use of local feed ingredients as rice bran, yellow corn, soybean meal (imported), copra meal and *Leucaena leucocephala* leaf meal were mixed with either 6%, 10% and 14% fish meal or vermimeal. Dicalcium phosphate, limestone and mineral-vitamin premix were added to the formulated rations to satisfy the other nutrient requirements of the birds. Table 1 shows the composition of the ration.

TABLE 1

The Dietary treatments.

FEED INGREDIENTS	A	B	C	D	E	F	G
Rice bran	10.00	11.00	11.00	11.00	22.50	16.00	C
Yellow corn	48.00	48.00	48.50	45.00	34.00	40.00	O
Soybean meal	26.50	22.50	17.00	26.20	23.50	17.50	M
Copra meal	3.00	3.00	3.00	4.00	3.00	5.00	M
Ipil-ipil leaf meal	4.00	4.00	5.00	5.00	4.00	5.00	E
Fish meal	6.00	10.0	14.00	—	—	—	R
Vermimeal	—	—	—	6.00	10.00	14.00	C
Dicalcium phosphate	1.30	0.35	0.30	1.45	1.75	1.50	I
Limestone	0.40	0.35	0.20	0.85	0.65	0.50	A
Salt	0.40	0.40	0.40	0.20	0.30	0.20	L
Vit.-Mineral Premix	0.40	0.40	0.60	0.30	0.30	0.30	MASH
Total (kg)	100	100	100	100	100	100	
Crude protein (%)	21.23	21.55	21.43	21.03	21.17	21.00	21.00
Metabolizable energy	2938	2963	2934	2956	2983	3031	
Calcium	0.91	0.82	0.93	0.91	0.97	0.81	
Phosphorus	0.56	0.46	0.56	0.48	0.60	0.55	

The birds were fed *ad. libitum* and water was made available at all times.

Eighty four one-day-old broiler chicks were randomly distributed to the seven dietary treatments with 6, 10 and 14% levels of either fish meal or vermimeal and commercial mash as the control following the Completely Randomized Design. Each treatment was replicated three times and each replicate had four birds.

The feeding trial lasted for forty five days.

Results

Production, Harvesting and Processing of Earthworms

The earthworms reared in goat manure in combination with *Leucaena leucocephala* substrate produced the highest gain in weight 258.10 g) having an initial weight of 57.00 g and a final weight of 315.10 g followed by cattle manure + *Leucaena leucocephala* (183.80 g) with an initial weight of 63.00 g and a final weight of 236.80 g. Supplementing the nutrients in the substrate with 100 to 400 g fermented kitchen scraps produced higher gain in weight. Fermentation of substrates was done by allowing the kitchen scraps to stand for one week in a plastic container or until they are thoroughly

fermented. The amount of feed supplement was directly proportional to the gain in weight. On the treatment combinations, earthworms reared in chicken manure + *Leucaena leucocephala* regardless of the level of feed supplement had the lowest weights.

Regarding the population, the goat manure and *Leucaena leucocephala* substrate which had an initial population of 50 produced the largest population (1290) per box which was significantly different to all substrates used ($P < 0.01$). The chicken manure + *Leucaena leucocephala* substrate which was also initially stocked with 50 earthworms produced the least (51) which was significantly different to the others. The earthworms in chicken manure + *Leucaena leucocephala* either died or went away from their boxes inspite of the measures done to keep them stay in their boxes. The feed supplements at a rate of 100 to 400 g per day had comparable results ($P < 0.01$).

The cost of production was computed based on the cost of boxes, light, water, substrates, feed supplement, depreciation cost and initial stock. Based on the computations, results reveal that it took ₱5.26 to produce 100 grams of earthworms using goat manure + ipil-ipil as substrates for the period of 90 days; ₱8.32 for cattle manure + ipil-ipil; ₱8.40 for swine manure + ipil-ipil; ₱14.78 for sawdust, rice hull and rice bran and ₱37.48 for the chicken manure + ipil-ipil. Highly significant differences between means was observed ($P < 0.01$). There was no significant differences on the cost entailed when the earthworms were given varying levels of feed supplement. On the interaction of the two factors, chicken manure + ipil-ipil regardless of the level of feed supplement had the most expensive cost of production (₱29.74 to ₱46.81) in contrast to the other treatment combinations which had values ranging from ₱4.84 to ₱14.93. (One dollar ($) is approximately 20 pesos (₱).

On harvesting earthworms, the pyramid method required 39.50 minutes to harvest earthworms from each box which was significantly better than directly separating the earthworms from the castings which required 66 minutes ($P < 0.05$).

It is necessary to kill earthworms prior to drying because alive earthworms will crawl away when exposed to sunlight. Freezing the earthworms for 8 to 12 hours gave the highest mean weight recovery (18.33%), however, this method was comparable when earthworms were killed by direct heating (15.00%), and using an oven-drier (17.00%) ($P < 0.05$). Blanching in hot water had the lowest mean weight recovery (13.00%) which was significantly different to freezing but comparable to the others ($P < 0.05$). It was observed that the earthworms' body readily split into soft unrecovable pieces when the temperature of the water was higher than 60°C.

Vermimeal as Substitute to Imported Fish Meal

On the evaluation of the nutritional value of earthworm meal on broilers, the gain in weight of birds given 14% vermimeal in the ration (1.104 kg) was just as good as those given the commercial mash (1.519 kg) and were better than the birds fed with the other dietary treatments ($P < 0.01$). On the other hand, the 6% level vermimeal (0.825 kg) gain in weight was inadequate to stimulate increased weight of birds whereas the 14% level of fish meal (0.762 kg gain in weight) was too high as a level in home-mixed broiler rations.

Regarding feed consumption, birds fed with commercial ration had significantly higher feed intake (3.84 kg) than those fed with ration with three levels of fish meal and vermimeal ($P < 0.01$). However, the feed consumption of birds fed with 10% vermimeal (3.13 kg) and 14% level vermimeal (3.23 kg) were comparable to each other but significantly different to the others.

Birds fed with commercial broiler mash had better feed conversion efficiency (2.54) than the birds fed with either the three levels of fish meal and vermimeal. The study further showed a trend that the increasing levels of vermimeal from 6% (3.29) to 14% (2.93) in the ration and the decreasing levels of fish meal from 14% (3.47) to 6% (2.95) in the ration tended to improve the feed conversion efficiency of birds.

The birds fed with commercial broiler mash (80.33%) and birds fed with 14% level vermimeal (78.60%) resulted to a higher dressing percentage over those birds fed with 6% fish meal (76.32%); 10% fish meal (77.94%) and 10% vermimeal (75.77%) ($P < 0.01$).

Furthermore, the birds fed with the seven dietary treatments did not differ significantly on their percent lean and percent bone.

TABLE 2

Cost and return analysis of the birds fed with fish meal and vermimeal (₱)

TREATMENTS	COST OF PRODUCTION (₱)	RETURNS PER LIVEWEIGHT (₱)	NET PROFIT (₱)
A - 6% Fish meal	23.20	28.01	4.81^{bc}
B - 10% Fish meal	24.22	28.77	4.55^{bc}
C - 14% Fish meal	23.38	23.49	0.11^{c}
D - 6% Vermimeal	23.24	25.26	2.02^{bc}
E - 10% Vermimeal	25.17	30.71	5.54^{b}
F - 14% Vermimeal	26.62	33.41	6.79^{b}
G - Commercial mash	32.87	45.44	12.57^{a}

CV = 15.50%

Means of the same letter are not significantly different at 1% level DMRT.

Feeding broilers with pure commercial mash entailed more cost, however, the net profit was significantly higher compared to the home-mixed rations. In the home-mixed rations, 10-14 % levels of vermimeal were comparable to all rations except 14 % fish meal. The results of the cost and return analysis is shown in Table 2.

One dollar ($) is approximately equal to twenty pesos (₱).

Discussion

Production, Harvesting and Processing of Earthworms

The organic wastes used in this study were suitable as a medium to raise earthworms. The results on the population and gain in weight of earthworms maybe due to the inherent characteristics of the goat manure that provided proper aeration and higher organic matter than the other substrates used Catalan (1). On the other hand, although chicken manure had a high organic matter, it had a high amount of uric acid which may not favor the increase of weight and number of earthworms. Likewise, Ogale (2) found out that earthworms grew best in cattle manure, however, he did not use goat manure as a substrate. Feed supplement in the form of fermented kitchen scraps provided additional nutrients to the earthworms.

The harvesting method known as pyramid harvesting was done by arranging the substrates as a pyramid or an inverted cone on top of a table. The worms in this method burrowed down near the bottom of the bedding to escape the light thus after removing all the substrates, a solid mass of earthworms will remain on top of the table.

Preliminary investigations on earthworm processing revealed that live earthworms when directly sundried crawled away from the container, hence "killing" methods were tested. The low percent recovery in blanching maybe due to the loss of the soft body tissues which were unrecoverable during blanching. When the earthworms were "killed" by putting in plastic bags and freezing overnight, the percent recovery was high because all parts of the earthworms were intact and dried under the sun. Drying of earthworms took 2-3 days.

Vermimeal as Substitute to Imported Fish Meal

Based on the proximate analysis done on vermimeal, the crude protein content was 54 percent as compared to the imported fish meal which has 60 percent. Although fish meal had a higher crude protein content, birds tended to eat more with 10 to 14 percent levels of vermimeal in their rations. This shows that higher levels of fish meal was more palatable to the birds because fish meal at high levels in the ration makes it salty. The results on feed consumption had the same findings as that of Ulep (3), i.e. birds preferred to eat higher levels of vermimeal. The feeds eaten by the birds are the sources of nutrients for the production of tissues and other organs of its body.

Conclusions

Based on the results of the study, earthworm production using goat manure + *Leucaena leucocephala* leaves, harvesting by the pyramid method and freezing earthworms overnight before drying were the best.

Ten to 14 % levels of vermimeal can substitute fish meal.

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