EFFECT OF THE INCORPORATION OF HIGH QUANTITIES OF FRESH EARTHWORMS (*Eisenia foetida*) IN THE DIET ON THE MORPHOLOGICAL GROWTH OF LOCAL MALAGASY BREED CHICKENS

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Abstract

The present study evaluated the effects of dietary incorporation of high quantities of fresh earthworms (Eisenia foetida) on the morphological growth of local breed chicken in Ambositra, Madagascar. In the trial, 21 young local breed chickens are divided into 3 identical batches containing 7 individuals per furnished cage, and raised for 4 weeks. Food T1 (40% earthworms), food T2 (50% earthworms) are formulated, tested and compared to the control food T0 (100% compound food). At 28 days of rearing, chickens supplied with T1 (40% earthworm) showed better morphological growth performance (gain in body height, length and width). Animals from T0 presented average performance. Chickens from T2 exhibited poor performance. In conclusion, these results indicate that the incorporation of fresh Eisenia foetida up to 40% into chicken feed is feasible and improves its size. This information helps breeders formulate earthworm-based chicken feeds, which could reduce production costs and improve farm profitability.

Keywords: *chicken, growth, morphology, earthworm, local breed, Ambositra*

1. INTRODUCTION

Poultry farming plays a major role in the world where the poultry population was estimated at 14 billion in 2000 [1]. Poultry creates a significant animal protein resource for the population [2, 3]. In recent years, poultry has been the second meat in the world, just behind pork, but ahead of cattle [4, 5]. Poultry meat is a relatively cheap and good quality product in terms of diet, rich in protein and low in fat [6]. In addition, it is the primary source of monetary income for rural households [7, 8]. The breeding of local Malagasy breed chickens, traditionally conducted for decades, is an activity that concerns 54% of the population [9]. This species of chicken is very appreciated by the population for the quality of the taste of its meat thanks to the production method considered organic. In a few years, improved breeding is practiced by Malagasy producers in order to shorten the production cycle by using industrially manufactured feed. Currently, the price of inputs usable for poultry feed is variable and continues to increase and become a constraint for the deployment of chicken farming. According to research carried out by some authors, chicken feed represents 60 to 80% of production costs [10]. This situation has led to a reduction in the profitability of the farm and has increased the vulnerability of the breeder. However, this increase in the cost of raw materials has led researchers to reduce the use of cereals and to promote alternative resources of animal proteins available locally and at a lower cost [10-15]. Among these food resources of animal origin, earthworms, in particular the species Eisenia foetida, are prominent. It is a local unconventional food resource, continuously available in Madagascar. The practice of earthworms in chicken feed has already shown good growth results in other countries [16-18]. Usually, researchers always practice the evaluation of weight growth of animals. But, the details and the palpable reference on the morphological data of local breed chicken are missing in the Amoron'i Mania Region. The capital of sufficient knowledge to serve as a basis for development and all the desirable characteristics for sustainable agriculture are deficient. The resolution of this lack of morphological reference constitutes the genesis of this present research. It is in this context that the study on the effect of the

incorporation of high quantity of fresh earthworms (Eisernia foetida) in the diet on the morphological growth of local breed chicken is undertaken in the Farm School of the Higher Institute of Technology of Ambositra (ISTA). The objective of this study is to evaluate the result of mixing this species of annelid for the two quantities (40% and 50%) in the ration of Malagasy local breed chickens.

2. MATERIALS AND METHODS

2-1. Study site

This study is carried out at the farm school of the Higher Institute of Technology of Ambositra (ISTA), in the capital of the Amoron'i Mania Region. It is part of the high plateau of Madagascar. Its altitude is between 1200 and 1500 m and has a tropical high-altitude climate. Annual precipitation varies around 1500 mm. Ambositra has two well-separated seasons: a cool and dry season from May to September and a hot and humid season from October to April [19]. The research work took place for 4 weeks, from June 22 to July 22, 2021.

2-2. Characteristics of raw materials used

Three types of raw materials were used: fresh earthworm, LFL starter feed and corn semolina **(Table 1)**. The earthworms used as chicken feed were previously raised within the experimental site. The LFL starter feed and cornmeal were purchased from the AGRIVET company's point of sale in Ambositra.

Table 1: Bromatological composition of the raw materials used

Raw material	Protein (%)	Fat (%)	Fiber (%)	Raw energy (Kcal/kg)	Ca (%)	P (%)
Earthworm	61,3±2,1	1,5±0,05	1,9	1942	0,5	0,9
LFL Starter	22,0	25,0	50,0	-	1	0,6
Cornmea	8,8	4,1	2,6	4450	0,5	2,9

2-3. Experimental design

The experiment was conducted in a henhouse comprising 3 batches. 21 young chickens of local breed aged 30 days were distributed in these batches. They were raised in a collective wire cage. Each batch had 7 chickens composed of 4 males and 3 females. One of these batches (T0) was fed with a diet containing 100% compound feed (Provende LFL + corn semolina) and without earthworms. Another batch (T1) was fed with a diet containing 40% fresh earthworms and 60% compound feed (Provende LFL + corn semolina). The last batch (T2) was fed with a diet containing 50% fresh earthworms and 50% compound feed (LFL Provende + corn semolina) **(Table 2)**.

Table 2: *Formulation of experimental foods*

Breeding day	Diet	T0	T1	T2
30 à 45 j	**Ingredients (%):**			
	Fresh Earthworms	0	40	50
	Corn Meal	35	21	17,5
	LFL Starter	65	39	32,5
	Total (%)	100	100	100
45 à 60 j	Fresh Earthworms	0	40	50
	Corn Meal	50	30	25
	LFL Starter	50	30	25
	Total (%)	100	100	100

T0: 100% compound feed, T1 : 40% arthworms + 60% compound feed, T2 : 50% arthworms + 50% compound feed

The tested product comes from the earthworm farm of this same school farm of the ISTA. The species of earthworm raised and distributed for chicken feed was that of Eisenia foetida. The chickens were fed and watered twice a day in the morning at 9 am and in the afternoon at 4 pm.

2-4. Data collection

All chickens are measured every 15 days of breeding. Three morphological parameters are considered: height at the withers, body length and width of the chicken body. The height is taken using a homemade measuring rod with 1 mm precision. The body length is measured with a metric tape with 1 mm precision. The body width is taken with a caliper with 1 mm precision.

2-5. Calculation of morphological parameters

To estimate the morphological growth of the chickens studied and characterize the efficiency of use of the different food rations tested, the following different morphological parameters (height gain, length gain, width gain) were calculated according to the following relationships (1), (2) and (3):

- ✓ **Height gain**
  GH = Hf-Hi (1)
  of which Hf: Final height, Hi: Initial height
- ✓ **Length gain**
  GL= Lf – Li (2)
  of which Lf: Final length, Li: Initial length
- ✓ **Width gain**
  GLr= Lrf – Lri (3)
  of which Lrf: Final width, Lri: Initial width

2-5. Statistical analysis

The obtained data were subjected to **one-way analysis of variance (ANOVA)**. Significant statistical differences were highlighted using "*All pairs Tukey Kramer HSD*" to compare the different means at the significance level of 0.05 and 0.01. **JMP/SAS software version 11.0.0** was used for statistical processing.

3. RESULTS

3-1. Effect of earthworm on chicken wither height growth

Table 3: *Mean of initial wither height, final wither height and wither height gain of chicken at 30 days of rearing*

Batch	T0	T1	T2	Prob.> F	Signification
Initial width (cm)	12,80±0,57a	12,81±0,57a	12,34±0,57a	0,80	ns
Final width (cm)	17,57±0,81a	18,44±0,81a	16,32±0,81a	0,20	ns
Width gain (cm)	4,77±0,32ab	5,62±0,32a	3,98±0,32b	0,0073	**

*T0: Control batch, T1: Batch treated with 40% earthworm, T2: Batch treated with 50% earthworm, ns: not significant, *: Significant at p < 0.05, **: Significant at p < 0.01*

Table 3 presents the average initial withers height, final withers height and withers height gain of chickens at 30 days of rearing. In this table, chickens fed with diet T1 (40% earthworm) showed higher final withers height (18.44±0.81 cm). Chickens fed with control diet T0 (100% compound feed) exhibited relatively intermediate final withers height average (17.57±0.81 cm). Animals treated with diet T2 (50% earthworm) appeared to have apparently lower final withers height (16.32±0.81 cm). According to ANOVA, there is no significant difference between the withers heights of chickens of the three tested batches (p >0.05). While the final withers height does not allow finding the effectiveness of earthworm.

Regarding the height gain at the withers, chickens fed with 40% earthworms presented a higher value (5.6±0.32 cm). Then, chickens treated with the control diet presented an average of intermediate height gain at the withers (4.77±0.32 cm). Chickens fed with 50% earthworms had a lower average height gain at the withers (3.98±0.32 cm). According to the ANOVA, there is a highly significant difference (p < 0.01) between the height gains at the withers of chickens from the 3 batches tested in favor of the quantity 40% earthworm. While the efficiency of distributing fresh earthworms in chicken feed is effective at this quantity 40%.

3-2. Effect of earthworm on chicken body length growth

Table 4: *Mean initial length, final length of chicken length gain at 30 days of rearing*

Batch	T0	T1	T2	Prob.> F	Signification
Initial width (cm)	11,90±0,36a	11,18±0,36a	11,50±0,36a	0,40	ns
Final width (cm)	16,22±0,36a	16,27±0,36a	15,60±0,36a	0,36	ns
Width gain (cm)	4,32±0,23ab	5,08±0,23a	4,10±0,23b	0,022	*

*T0: Control batch, T1: Batch treated with 40% earthworm, T2: Batch treated with 50% earthworm, ns: not significant, *: Significant at p < 0.05, **: Significant at p < 0.01*

According to this **Table 4**, at 30 days of rearing, chickens fed with 40% earthworm showed higher body length (16.27±0.36 cm). Chickens fed with the control diet without earthworm showed relatively intermediate body length (16.22±0.36 cm). Chickens treated with 50% earthworm showed the mean body length apparently lower

(15.60±0.36 cm). According to ANOVA, there is no significant difference ($p > 0.05$) between the mean body length of chickens of the 3 batches.

For length gain, chickens from the batch fed with 40% earthworm showed higher length gain (5.08±0.23 cm). Subsequently, chickens from the control exhibited mediator length gain (4.32±0.23 cm). Chickens treated with 50% earthworm exhibited lower length gain (4.10±0.23 cm). According to ANOVA, there is a significant difference between treatments at $p < 0.05$. While the efficiency of earthworm distribution on chicken body length growth is palpable.

3-3. Effect of earthworm on width growth

Table 5: *Mean initial width, final width and width gain of chicken at 30 days of rearing*

Batch	T0	T1	T2	Prob. > F	Signification
Initial width (cm)	4,31±0,27a	5,07±0,27a	4,38±0,27a	0,07	ns
Final width (cm)	6,80±0,40a	7,68±0,40a	6,38±0,40a	0,09	ns
Width gain (cm)	2,50±0,21ab	2,61±0,21a	2,00±0,21b	0,04	*

*T0: Control batch, T1: Batch treated with 40% earthworm, T2: Batch treated with 50% earthworm, ns: not significant, *: Significant at $p < 0.05$, **: Significant at $p < 0.01$*

Table 5 presents the means of chicken body width at the beginning and end of the trial. According to this table, chickens from the batch treated with 40% earthworm showed apparently higher final body width (7.68±0.40 cm). Chickens fed with control diet without earthworm showed intermediate body width (6.80±0.40 cm). Chickens fed with 50% earthworm showed lower final body width (6.38±0.40 cm). According to ANOVA, there is no significant difference between the treated batches ($p > 0.05$). While the final chicken body width does not allow to find the effectiveness of earthworm on chicken morphological growth. For the width gain at 30 days of rearing, chickens fed with 40% earthworm showed higher value (2.61±0.2 cm). Then, chickens fed with the control diet without earthworm showed intermediate width gain (2.50±0.21 cm). Chickens from the diet containing 50% earthworm showed lower width gain (2.00±0.21 cm). According to the ANOVA, there is a significant difference between the treatments ($p < 0.05$). While the efficiency of distributing fresh earthworm at 40% of its diet is proven on the gain of width of the chicken body.

4. DISCUSSION

4-1. Effect of nutritional composition on chicken growth

According to the measurements carried out, chickens fed with 40% earthworm mixed with 60% compound feed always showed the best growth gain for all morphological parameters considered (Height, Length, Width). All statistical results mentioned significant differences ($p < 0.05$ and $p < 0.01$). This consequence justifies the clarity of the diversity between the tested batches and subsequently confirms the positive effectiveness of the presence of sufficient earthworm in the feed of local breed chicken in batch T1. The feed in the control batch (T0) without earthworm, but 100% compound feed (LFL feed mixed with corn semolina) is considered as a complete reference feed already used by experienced breeders in Ambositra for the fattening of local breed chicken. In this test, this reference feed is surpassed by batch T1 using 40% earthworm. This result still illustrates the superiority of this type of feed containing 40% earthworm which is considered well balanced. This consequence agrees with the zootechnical interest of earthworm in animal feed found in previous research [20-22]. The feed in batch T2 composed of 50% earthworm and 50% compound feed still presented the lower growth of chickens. The difference is significant at $p < 0.01$. This result indicates the poor dietary balance in this batch T2. Compared to other batches, the amount of earthworm increases to replace the mass of compound feed based on cereal grain. The poor growth of chicken in this batch means that the amount of earthworm cannot replace the role of cereals within a certain limit. While this amount used in batch T2 (50% earthworm and 50% compound feed) is not recommended for breeders. This finding is consistent with the authors' opinion that the risks of contamination associated with the use of earthworms in poultry feed must be taken into account [18].

According to previous research, in relation to dry matter, earthworms contain 55 to more than 70% protein and contain the six essential amino acids (leucine, lysine, valine, isoleucine, threonine and methionine) [23]. This very interesting nutritional value is well exploited by chickens in the batch fed with 40% earthworms. These nutrients provided are very necessary for bone growth to boost the development in length and height of chickens to have the best gain in morphological growth. This result is consistent with that of previous research indicating that unconventional food resources (insects, earthworms, animal droppings) are solutions to the protein needs of animals [18].

4-2. Height Growth

In this study in Ambositra, the height at the withers of 60-day-old chickens is on average 18.4 cm in the T1 batch which has the best growth. This result is largely superior to those found in the previous research which found a height of 9.6 cm at 60 days of breeding in a study of conformation of the Malagasy local breed chicken in Antananarivo [24].

4-2. Length Growth

In this trial in Ambositra, the best length of the trunk of 60-day-old chicken is on average 16.27 cm. This result is consistent with the previous study concerning the conformation of Malagasy local breed chickens [24]. Contrary to this result, a previous research found a length of the body of female chicken of 20.4±2.4 cm [25].

4-3. Growth in Width

From this study in Ambositra area, the average width of the chicken body recorded at 60 days is 6.8 cm. This result is higher than those recorded in a previous study for the conformation of local Malagasy breed chicken [24]. These differences could be due to the quality of feed used. The richness in protein and essential amino acids provided by the earthworm covers the need for chicken muscle growth. This effect is reflected in the good development of chicken in width. While the sufficiency of earthworm in addition to the compound feed improves the size and conformation of chicken in batch T1 compared to other treatments. Therefore, the incorporation of fresh earthworm in the diet of local breed chicken is feasible and improves the morphology and size of chicken as well as the profit of the breeding farm. The incorporation of earthworms at 40% of the chicken ration reduces the operating cost by up to 13%. This result is consistent with previous information indicating that the use of earthworms leads to an improvement in the profitability of poultry production [25]. Therefore, this study allows breeders to find knowledge on a good use of this resource of protein of animal origin at a lower cost and continuously available.

5. CONCLUSION

The present study aimed to see the effect of the distribution of fresh earthworm on the morphological growth of young chickens of local breed. Three diets are formulated: Control diet T0 without earthworm and 100% compound feed, Diet T1 with 40% earthworm and 60% compound feed and Diet T2 with 50% earthworm and 50% compound feed. The results suggested that whatever the morphological parameters measured (Height, Length and Width), the diet T1 with 40% earthworm always showed the best gain in morphological growth. Fresh earthworm also improves the size and conformation of local breed chicken. The amount of worms more than 40% is not recommended. This study allows breeders to know a good practice of this resource of protein of animal origin at a lower cost and continuously available.

REFERENCES

[1]-FAO, «Rapport annuel Perspective agricole de l'OCDE et de FAO », (2014)

[2]-Y. ISSA, Commercialisation et consommation de la volaille traditionnelle en Afrique, (2012) 14p

[3]-M. KOKO, O. F. MAMINIAINA, J. RAVAOMANANA, S. J. RAKOTONINDRINA, « Aviculture villageoise à Madagascar: Productivité et performance de croissance ». (2015) 137-145. http://www.researchgate.net/publication/280533931(consulté le 12/02/2023).

[4]-A. HUART, « La production de volaille dans le monde et en Afrique ». Troupeaux et cultures des tropique, (2003) 81 p

[5]-M. PIERRE, « Contexte de la filière avicole », (2013) 110p

[6]-ITAVI,«Le marché mondial des viandes de volailles». In : La production de poulets de chair en climat chaud, 2ème éd, Rennes : Ed ITAVI, (2003) 110p.

[7]-B. OUEDRAOGO, B. BAYALA, J. S. ZOUNDI, L. SAWADOGO, «Effet de l'incorporation de grains d'Hibiscus sobdirifa (Oseille de Guinée) dans l'alimentation sur quelques paramètres d'ingestion et de croissance du poulet en aviculture traditionnelle améliorée au Bourkina Faso». Agronomie Africaine, 27(3)(2016) 269-283.

[8]-S. B. AYSSIWEDE, R. MISSOKO, MEBEK, A. MANKOR, A. DIENG, M. R. HOUINATO, C. A.A.M. CHRY SOSTOME, M. DAHOUDA, A. MISSOHOU, J. L. HORNICK, «Effet de l'incorporation de la farine de feuilles de Cassia tora (Linn) dans la ration alimentaire de jeunes poulets traditionnels du Sénégal». Revue Méd. Vét., 16 3, 8 – 9 (2012) 375 – 386

[9]-INSTAT, Enquête périodique auprès des ménages en 2010, (2011).

[10]-M. DAHOUDA, S. TOLEBA, M. SENOU, A. YOUSSAO, HAMBUCKERS,«Les ressources alimentaires non-conventionnelles utilisables pour la production aviaire en Afrique. Valeur nutritionnelles et contraintes». Ann. Med. Vet., 153(2009) 5-21.

[11]-G. A. MENSAH, « Elevage non conventionnel des espèces animales et développement durable en République du Benin ». Bulletin de la Recherche Agronomique 21 (1998) 13-27.

[12]-H.S. PRAYOGI, «The effect of Earthworm Meal Supplementation in the Died on Quail's Growth Performance in Attempt to Replace the Usage of Fish Meal». Int. J. Poult. Sci. 10(10) (2011) 804-806.

[13]-S. W.JAMES, G. B. DIVINA, «Earthworms (Clitellata : Acanthodrilidae, Almidae, Eudrilidae, Glossoscolecidae, Ocnerodrilidae) of the coastal region of Gamba, Ogooué-Maritime Province, southwestern Gabon». Zootaxa 3458(1) (2012) 133-138.

[14]-S. POUSGA, F. SANKARA, K. COULIBALY, J.P. NACOULMA, S. OUEDRAOGO, M. KENIS, C. CHRYSOSTOME et G.A. OUEDRAOGO, « Effet du remplacement de la farine de poisson par les termites (Macrotermes Sp) sur l'évolution pondérale et les caractéristiques de carcasse de la volaille locale au Burkina Faso ». Afr. J. food Agric. Nutr. Dev. 19(2) (2019) 14351-14371.

[15]-B. B. BATIMSOGA, S. B. AYSSIWEDE, E. TALAKI, B. DAO BALABADI, Y. LOMBA & K. E. KPEMONA, « Valeur nutritive et effets de l'incorporation de la farine de termites (Macrotermes sp) dans l'aliment des poussins locaux sur leurs performances de croissance en Togo ». Science de la vie, de la terre et agronomie. Rev.Ramres-vol.08 Num.02(2020) 81-89.

[16]-P. M. BARCELO.,«Production and utilisation of arthworms as feeds for broilers in the Philippines». Tropicultura, 6 (1988) 21-24

[17]-B. A. DJOSSA, B. K. ALISSOU, G. A. MENSAH et B. A. SINSIN, «Performance de production de biomasse du ver de fumier Eisenia foetida sur différents substrats ». Bulletin de Recherche Agronomique du Bénin. n°75-vol 1 (2014) 26-31

[18]-P. BYAMBAS, N. MOULA, F. FRANCIS, J. L. HARNICK, « Perspectives zootechniques et économiques au ver de terre Eudrillus eugeniae dans l'aviculture au Gabon ». Sciences de la vie, de la terre et agronomie. REV. RAMRES. VOL 08 (2) (2020) 73-79.

[19]-R. D. RABENANAHARY et P. RABEMANDRESY, «Monographie de la Région d'Amoron'i Mania » Direction Régionale du Développement Rural Amoron'i Mania, Madagascar, (2011)pp. 4-5.

[20]-E. MORIN, « Le lombricompostage : Guide pratique, Eco-quartier, Montréal, (2004) 20

[21]-O. E. MORON-FUENMAYO R, D. DIAZ, S. PIETROSEMOLI, R. BARRERA, N. GALLARDO, J. PENA & M. LEAL, «Efecto de la inclusion de harina de lombriz sobre el rendimiento en canal, en cortes y calidad fisico-quimica de la came de codorniz (cotumix cotumix japonica) TT- Effect of earthworm (Eisenia spp) meal inclusion on dressing and physical-chemical cha». Rev. la Fac. Agron. 25(4) (2008) 674-684.

[22]-J. MOREKI & B. TIROESELE, «Termites and Earthworms As Potential Alternative Sources of Protein for Poultry». Int. J. Agro Vet. Med. Sci. 6(5) (2012) 368.

[23]-C. A. EDWARD, «Production of feed protein from animal waste by earthworms». Phil. Trans. R. Soc. Land. B.,310 (1985) 299-307.

[24]-F.H RICHARD, R. ROUVIER, « Analyse statistique préliminaire concernant le poids et mensurations corporelles du poulet vivant » Ann. Zootech., (1965), 14 (2), 191-212.

[25]-C. V. YAPI-GGAORE, N. E. LOUKOU, A. S. P. N'GUETTA, B. KAYANG, X. ROGNON, M. TIXIER-BOICHARD, G. TOURE, Y. COULIBALY, I. YOUSSAO, «Diversités phénotypique et morphométrique des poulets locaux (Gallus gallus) de deux zones agro écologiques de Côte d'Ivoire » Cah Agric. Vol. 19. N°6 (2010) 439-445.