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Research Application Summary

The growth performance of indigenous chicken fed on diets containing black soldier fly larvae meal

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Abstract

Indigenous chicken (IC) contribute significantly to human nutrition as a cheap source of animal protein. Demand for IC products has been on the increase in both rural and urban areas due to increased preference for white meat, low fat content and the perceived special flavour. The enterprise has hence been identified as one with high potential to improve livelihoods and to ensure developing countries become food secure. However, IC production has been characterized by low productivity mainly attributed to poor nutrition, among other factors. Previous studies have revealed that feed cost constitutes about 70% of total poultry production costs. Thus, the high cost of feed resources especially protein concentrates and their limited availability continue to discourage the uptake of commercial IC production as a source of livelihood in Kenya. Studies elsewhere have identified Black soldier fly larvae (BSFL) meal as an alternative feed resource. This study aimed to provide information on the nutritive value of locally prepared BSFL meal and to determine the growth performance of improved indigenous chicken fed on diets containing graded levels of the meal. The study was conducted at the Kenya Agricultural and Livestock Research Organisation (KALRO), Naivasha. A total of 300 KALRO improved indigenous chicken day old chicks were used for the feeding trial and taken through the chick and grower phases. Five diets in each phase were formulated to meet the National Research Council (1994) requirements for poultry with BSFL meal included at the rate of 0%, 5%, 10%, 15% and 20% designated as D0, D1, D2, D3 and D4 respectively to replace fishmeal and soybean meal. The five dietary treatments were randomly allocated to the 50 experimental units (replicates) of 6 birds each, with each treatment replicated 10 times in a completely randomized design. Results showed no significant influence of the dietary treatments on the final body weight of the chicks, the daily weight gain, and feed intake. However, there was a significant ($P<0.05$) difference in food conversion ratio (FCR) with diets containing BSFL meal having the highest FCR. The results show that BSFL meal can replace soybean and fishmeal in IC diets without any detrimental effect on the growth rate of the chicken.

Key words: Indigenous chicken diet, Kenya, poultry feed

Résumé

Le poulet indigène (IC) contribue de manière significative à la nutrition humaine en tant qu'une source moins chère de protéines animales. La demande de produits IC a augmenté dans les zones rurales et urbaines en raison de la préférence accrue pour la viande blanche, la faible teneur en matières grasses et la saveur spéciale perçue. L'entreprise a donc été identifiée comme étant à fort potentiel pour améliorer les moyens de subsistance et garantir la sécurité alimentaire des pays en développement. Cependant, la production du cet IC a été caractérisée par une faible productivité, principalement attribuable à une mauvaise nutrition, parmi les autres facteurs. Des études antérieures ont révélé que le coût d'alimentation représente environ 70% du coût total de production de la volaille. Ainsi, le coût élevé des ressources alimentaires, particulièrement les concentrés de protéines et leur disponibilité limitée continuent de décourager l'adoption de la production commerciale de l'IC comme source de revenus au Kenya. Ailleurs, des études ont identifié la farine de larves de mouche soldat noire (BSFL) comme une source d'alimentation alternative. Cette étude visait à fournir des informations sur la valeur nutritive des farines BSFL préparées localement et à déterminer les performances de croissance de poulets indigènes améliorés nourris avec des régimes contenant des niveaux gradués de farine. L'étude a été menée à l'Organisation de Recherche Agricole et d'Elevage du Kenya (KALRO), Naivasha. Au total, 300 poussins indigènes de KALRO améliorés d'un jour ont été utilisés pour l'essai d'alimentation et fait passés à travers les phases de poussin et d'élevage. Cinq régimes dans chaque phase ont été formulés pour répondre aux exigences du Conseil national de recherches (1994) pour les volailles avec la farine BSFL ont étaient inclus au taux de 0%, 5%, 10%, 15% et 20% et désignés en tant que D0, D1, D2, D3 et D4 respectivement pour remplacer la farine de poisson et celle de soja. Les cinq traitements alimentaires ont été attribués au hasard aux 50 unités expérimentales (répétitions) contenant 6 poussins chacune, avec chaque traitement répété 10 fois dans un dispositif complètement randomisé. Les résultats ont montré qu'il y avait aucune influence significative des traitements alimentaires sur le poids corporel final des poussins, le gain de poids journalier et la prise alimentaire. Cependant, il y avait une différence significative ($P < 0,05$) dans le taux de conversion alimentaire (FCR) avec les régimes contenant de la farine BSFL ayant le FCR le plus élevé. Les résultats montrent que la farine de BSFL peut remplacer le soja et la farine de poisson dans les régimes IC sans aucun effet néfaste sur le taux de croissance du poulet.

Mots clés : Régime de poulet indigène, Kenya, aliments pour volaille

Introduction

The demand for animal products is expected to increase by 60-70% concurrently with the projected increase in world human population to 9.1 billion by 2050. The demand has caused a tremendous growth in livestock production, led by the poultry sector. Poultry production contributes significantly to food security through provision of cheap protein, energy and essential micro-nutrients to humans. This is through their ability to use a wide range of agricultural by-products and wastes to produce eggs and meat in short production cycles (Mottet and Tempio, 2017). The growing populations, urbanisation and rising incomes have increased the demand for meat and eggs, thus greatly contributing to the fast growth of the poultry sector globally with chicken being most abundant and widely

reared form of poultry. Indigenous chicken (IC) contribute 30% of all the globally consumed white meat. The IC make up over 70% of the total chicken population in Africa, and they are mainly kept by smallholder farmers. They are extensively spread in rural and peri-urban areas, playing a significant role in generating income and food production. They hence, play a significant role to the rural economy in developing countries especially due to their ability to tolerate poor husbandry and harsh environmental conditions (Padhi, 2016). Indigenous chicken's contribution to food security and its importance as a poverty alleviation strategy cannot be underrated and its potentials should be enhenced, explored and harnessed.

In Kenya, indigenous chicken sub-sector has been acknowledged as a significant economic tool for poverty alleviation in rural households. The estimated national poultry population is 31.8 million out of which 25.7 million accounts for indigenous chicken. The IC contribute to egg and meat production which account for about 47 and 55%, respectively, thus playing a key role in provision of affordable animal protein to the country's rural population (Kingori et al., 2010). However, despite the significant contribution to the rural economy, the IC potential benefit has not been fully exploited in Kenya. Urbanisation and the steady rise of health-conscious consumers has also led to a consistent increase in the demand for IC products. However the supply of indigenous chicken products (meat and eggs) has continuously been affected by low IC productivity (Alders et al., 2016). Improving the productivity of IC has been the key focus for many development initiatives in developing countries including Kenya. The low productivity of IC is linked to; lack of disease control measures, poor housing and poor nutrition (Kingori et al., 2010). Despite the intervention to improve the low productivity of IC especially through breeding and feed supplementation, the uptake and sustainability of these interventions is still low. The high cost of formulated feeds due to high unavailability of feed resources being the major concern (Khobondo et al., 2014). This has been occasioned by the increasing human population in Kenya and the world which has caused competition between human and animals for food and feed. The supply of fishmeal (FM) and cereals which are major feed sources for formulation of poultry feeds has therefore continued to be affected. The effect is particularly experienced in FM and soybean meal (SM) which serve as the main sources of protein in poultry feeds (van Huis, 2015). The sustainability of IC diets is hence, vital in the development of smallholder poultry production especially in the developing countries. The unavailability of adequate supply of good quality and affordable feed ingredients makes it essential to give more consideration to alternative protein sources to be used in poultry feeds. The prospects of exploring alternative sources of proteins are hence, feasible especially if they are easily accessible, affordable and locally available all year round.

Researchers have identified insect rearing as one of the ways that could enhance food and feed security (Makkah *et al.,* 2014; van Huis, 2015; Onsongo *et al.,* 2018). The main reason being their high nutritive value, high feed conversion efficiency and their ability to feed on various feed sources. Insects are readily available; they grow and reproduce quickly, and have high feed conversion rates. Black Soldier Fly Larvae (BSFL) has been identified as one alternative protein source with immediate potential, with the next decade expected to witness widespread use of insect as feedstock in poultry feed. Their crude protein level range between 42-63% and they have high protein digestibility and good palatability and could hence, be a valuable resource in IC diets as a readily available and affordable substitute protein source (Makkar *et al.,* 2014). This could be a key intervention in addressing feed shortage which leads to poor IC nutrition, one of the major constraints in IC production in Kenya (Kingori *et al.,* 2010).

This study therefore, aimed at contributing to food security through improved IC production by use of BSFL as protein substitute for conventional protein sources in IC diets. The study evaluated the effects of using BSFL meal based diets at different levels of inclusion on the growth performance of improved IC chicks and growers. This contributed to the knowledge on the suitability of BSFL meal as an alternative proteins source in improved IC chicks and growers diets. This was achieved through evaluating the effects of using BSFL meal-based diets at different levels of inclusion on the growth performance of improved IC chicks and growers.

Materials and Methods

The experiments was carried out at Kenya Agricultural and Livestock Research Organization (KALRO), at the Non-ruminant Research centre situated at Naivasha, Nakuru County, Kenya Located at GPS coordinates 00 43' 0.0120" S and 360 26' 9.2760" E, latitude -0.71667, longitude 36.43591 and at altitude of 1915 M. The average annual precipitation and temperature are 636mm and 17.2^{o}C, respectively.

Five diets were formulated for chicks and growers with BSFL replacing fishmeal at the rate of 0%, 5%, 10%, 15% and 20% designated as Control (D0), D1, D2, D3 and D4 respectively. The chicks and growers' diets were formulated to meet National Research Council (NRC) (1994) nutrient requirements for poultry. Black Soldier Fly Larvae was sourced from International Centre of Insect Physiology and Ecology, (ICIPE) Nairobi while other ingredients were purchased from the local suppliers. The chick and growers' diets were fed to the birds from week 2 to week 8 and week 10 to week 18, respectively.

The five diets were randomly allocated to the experimental units (cages), with 6 birds each and replicated 10 times in a Completely Randomized Design. Standard health and biosecurity measures were observed throughout the experimental period to forestall any disease outbreak. All birds were kept under similar conditions and water provided ad libitum. The birds were weighed in each experiment unit at the beginning and weekly thereafter. Daily feed intake per experimental unit was recorded. The mortality was also recorded in each experimental unit throughout the experimental period.

Data were subjected to the analysis of variance (ANOVA) to determine the effect of the different diets on performance parameters. Bon-tukey was applied to differentiate the means that were statistically different at $P<0.05$ level of significance.

Results and Discussion

The results of the growth performance of indigenous chicken fed on diets containing black soldier fly larvae meal indicate that the initial and final body weight of the chicks were similar in all the dietary treatments despite the final body weight in D0 being numerically higher than the other dietary treatments (Table 1). The difference in daily weight gain (DWG) was also not significant despite the control having a numerically higher DWG as compared to the other treatments (Figure 1). According to Cutrignelli *et al.* (2018) this

could be as a result of a higher apparent digestibility of crude protein as well as dry and organic matter in the D0 as compared to the dietary treatments with BSFL meal.

Table 1. Effect of Black soldier fly larvae meal in diets on growth performance of KALRO improved Indigenous chicken

Parameter	D0	D1	D2	D3	D4
Initial body weight (g)	63.60[a]	69.55[a]	63.69[a]	71.71[a]	69.63[a]
Final body weight (g)	602.53[a]	449.38[a]	532.89[a]	510.10[a]	459.64[a]
Daily weight gain (g)	10.76[a]	8.02[a]	9.52[a]	9.11[a]	8.21[a]
Daily feed intake (g/day)	33.99[a]	41.44[a]	35.34[a]	34.53[a]	39.47[a]
Feed conversion ratio	2.50[a]	4.66[b]	2.93[a]	3.81[ab]	3.82[ab]

Means in the same row having different superscript are significantly different

In this study, there was no significant influence on the daily feed intake (DFI) by the dietary treatments. However, the IC chicks fed on DI and D4 recorded a higher FI as compared to the rest of the treatment groups (Table 1). The results are similar to those reported by Dajiru *et al.* (2016), where they indicated no significance variation on daily body weight at the starter phase of Spring chicken fed on BSFL meal at different inclusion levels. BSFL dietary treatments were also indicated to have no effect on weight gain and feed intake of layers in study by Maurer *et al.* (2016). The food conversion ratio (FCR) in D0 the control treatment was significantly different to D1 (P=0.0001), D3 (P=0.004), and D4 (P=0.004) but had no significant difference to D2 (P =0.734). The dietary treatment D1 at 5% BSFL meal inclusion level had the highest FCR and the control D0 at 0% BSFL meal inclusion level had the lowest FCR (Table 1). The increase of FCR in the BSFL meal based diet indicated poor feed utilization which could be attributed to the effect of chitin (Al-Qazzaz *et al.,* 2016).

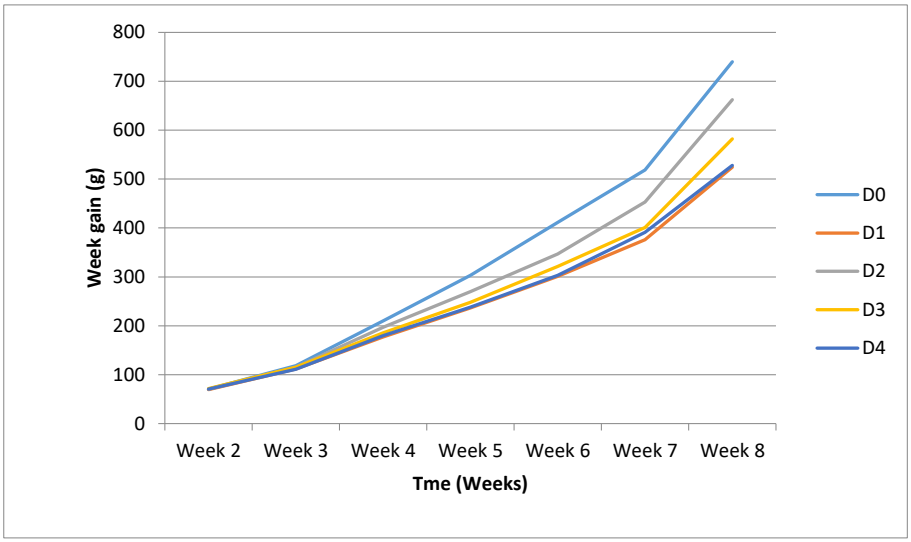

Figure 1. Graph showing the weight of KALRO improved Indigenous chicken

Conclusion

The results of this study indicates that BSFL meal can be used as an alternative protein source in IC chicks' diets without having a significant impact on their growth performance. The use BSFL meal was assessed and confirmed to have no significant influence on feed intake and weight gain. The significant difference in FCR with D2 having the least FCR in the treatments with BSFL meal. This indicates the 10% BSFM meal inclusion level D2 was the most suitable for IC chicks.

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