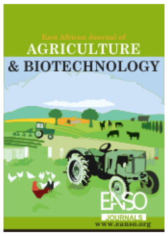


East African Journal of Agriculture and Biotechnology

eajab.eanso.org

Volume 6, Issue 1, 2023

p-ISSN: 2707-4293 | e-ISSN: 2707-4307

Title DOI: https://doi.org/10.37284/2707-4307

EAST AFRICAN NATURE & SCIENCE ORGANIZATION

Original Article

Effect of Maggot Meal-Based Multi-Nutrient Blocks on Slaughter Weight and Internal Organ Characteristics of Rabbit Weaners

Passmore Temba Mudhanganyi[1], Calleb Olweny Ochia[1] & James Madzimure[2]*

[1] Jaramogi Oginga Odinga University of Science and Technology, P.O. Box 210, 40601 Bondo, Kenya.
[2] Chinhoyi University of Technology, Private Bag 7724, Chinhoyi, Zimbabwe
* Author for Correspondence https://orcid.org/0009-0005-3568-6625; Email: pmudhanganyi@gmail.com

Article DOI: https://doi.org/10.37284/eajab.6.1.1644

Date Published:

19 December 2023

Keywords:

Rabbits, Maggots.

ABSTRACT

House fly maggot is a potential insect that has a relatively high crude protein and mostly used in feeding monogastric animals. Twenty-four Chinchilla giganta rabbit weaners (12 males and 12 females) were used in this experiment in a randomised complete block design. Each rabbit weaner was randomly allotted to four different treatments. Each treatment was replicated three times with two rabbits per replicate. Sex was used as a blocking effect. This was done to evaluate the effects of graded levels of maggot meal-based multi-nutrient block on feed intake, daily weight gain, feed conversion ratio and internal organs weight during feeding for 56 days at Chinhoyi University of Technology farm. Feed formulation was done using I.D.T Try and Error Iteration software. Sun-dried maggot meal was used to produce four iso-nitrogenous and iso-energetic treatment multi-nutrient block diets with 0%, 5%, 10% and 15% maggot meal. An increase in the inclusion level of maggot meal had a positive effect on feed intake (P<0.05 Results from this study in rabbits revealed that although maggot meal-based diets were iso-nitrogenous (18% CP level), they differed in mean live weight gain (LWG). The study found that diets where 10-15% of housefly maggot meal was included achieved better growth rates and internal organ weights relative to soya bean meal-based diets. These maggot meal levels represent 50-80% partial replacement of soya bean meal in the diet. However, diets did not differ in heart weight. These results suggest that housefly maggot meal is a good source of protein and a suitable replacement for soya bean meal in the diets of growing rabbits post-weaning. Dietary inclusions of up to 150 g/kg (50-80% dietary replacement of soya bean meal) were recommended to ensure optimum growth performance and body composition of growing rabbits. Commercial use of this insect meal as a feed ingredient in rabbit diets would depend on industrial-scale production of the larvae and reduced costs of maggot meal.

Article DOI: https://doi.org/10.37284/eajab.6.1.1644

APA CITATION

Mudhanganyi, P. T., Ochia, C. O., & Madzimure, J. (2023). Effect of Maggot Meal-Based Multi-Nutrient Blocks on Slaughter Weight and Internal Organ Characteristics of Rabbit Weaners. *East African Journal of Agriculture and Biotechnology*, *5*(1), 484-492. https://doi.org/10.37284/eajab.6.1.1644

CHICAGO CITATION

Mudhanganyi, Passmore Temba, Calleb Olweny Ochia and James Madzimure. 2023. "Effect of Maggot Meal-Based Multi-Nutrient Blocks on Slaughter Weight and Internal Organ Characteristics of Rabbit Weaners". *East African Journal of Agriculture and Biotechnology* 6 (1), 484-492. https://doi.org/10.37284/eajab.6.1.1644

HARVARD CITATION

Mudhanganyi, P. T., Ochia, C. O., & Madzimure, J. (2023) "Effect of Maggot Meal-Based Multi-Nutrient Blocks on Slaughter Weight and Internal Organ Characteristics of Rabbit Weaners", *East African Journal of Agriculture and Biotechnology*, 6(1), pp. 484-492. doi: 10.37284/eajab.6.1.1644.

IEEE CITATION

P. T. Mudhanganyi, C. O. Ochia, & J. Madzimure, "Effect of Maggot Meal-Based Multi-Nutrient Blocks on Slaughter Weight and Internal Organ Characteristics of Rabbit Weaners", *EAJAB*, vol. 6, no. 1, pp. 484-492, Dec. 2023.

MLA CITATION

Mudhanganyi, Passmore Temba, Calleb Olweny Ochia & James Madzimure. "Effect of Maggot Meal-Based Multi-Nutrient Blocks on Slaughter Weight and Internal Organ Characteristics of Rabbit Weaners". *East African Journal of Agriculture and Biotechnology*, Vol. 6, no. 1, Dec. 2023, pp. 484-492, doi:10.37284/eajab.6.1.1644.

INTRODUCTION

Food insecurity is a grave issue in developing nations all over the Globe (Mahmood et al., 2014). According to Molen (2016), approximately 868 million people are undernourished, and these make up 12.5% of the world's population, of which 852 million are in the developing world. Sub-Saharan Africa has not been spared from undernourishment, having 26.8% of the total population numbering up to 234 million people suffering from hunger. Zimbabwe is one of the sub-Saharan countries that has been severely impacted by climate change (Manyeruke *et al*., 2013). Mupepi and Matsa (2021) reported Zimbabwe as one of the countries with the most irregular rainfall patterns in the region in terms of temporal and spatial distribution. The unreliable rainfall patterns, characterized by recurrent droughts in some parts of the country and flooding in others have led to food insecurity.

Animal production is resource-demanding as it covers 30% of the world's ice-less surface (including crop and pasture land) and consumes 8% of global human water use, mainly for the irrigation of feed crops (Foley, 2011). Mekonnen & Hoekstra (2013) reported that animal products have a much higher water footprint than plant-based foods. In order to reduce pressure on land and water resources, and reduce the protein carbon footprint, a quest for novel feed ingredients is a must. Insect protein is one of the environmentally and resource sustainable resources to enhance food and feed security (Huis, 2013). The common housefly is among the popular insects reared for feed. Houseflies grow and reproduce easily, have a very short life cycle and can and can be reared on bio-wastes.

Other insects that have been found feasible and successfully reared for poultry and other micro-livestock include crickets, black soldier flies and mealworms. The target has been micro-livestock because of their versatility. They have a high growth rate, food conversion efficiency, and they emit lower greenhouse gases. Houseflies grow and reproduce easily, have a very short life cycle and can and can be reared on bio-wastes (Makkar *et al*., 2014). Other insects that have been found feasible and successfully reared for poultry and other micro-livestock include crickets, black soldier flies and mealworms (Bosch *et al.*, 2018; Meneguz *et al*., 2018). The target has been micro-livestock because of their versatility (Makinde, 2015). They have a high growth rate, food conversion efficiency, and they emit lower greenhouse gases (Oonincx *et al.*, 2010).

Article DOI: https://doi.org/10.37284/eajab.6.1.1644

Rabbits are among the micro-livestock which have been suggested as a rapid means of obtaining animal proteins for human consumption (Abu *et al.*, 2008; Beinpuo, 2009; Assan, 2014). However, there is limited research that was done on the use of housefly maggot meal as rabbit feed. The rabbit (*Oryctolagus cuniculus*) has the greatest potential to sustainably produce high-quality animal-based protein for the increasing population size of the Less Economically Developed Countries (LEDCs) (Owen & Dike, 2013). The following are the attributes low-cost management requirements, small-bodied size, short generation interval, fecundity, rapid growth rate, genetic diversity, ability to utilize forage and agricultural by-products, and adaptation over a wide range of ecological environments. This study hypothesized that including housefly maggot meal in rabbit weaner meals will improve growth performance and reduce time taken to reach market weight.

MATERIALS AND METHODS

Research Site

The study was carried out at the Chinhoyi University of Technology farm rabbit unit. Most of the laboratory work was done at Chinhoyi University of Technology's Animal Production and Technology Nutrition laboratory. The University farm is situated in Chinhoyi, Makonde District, Mashonaland West Province in central northern Zimbabwe its geographical coordinates are 17° 21' 0.00" S, 30° 12' 0.00" E (latitude: 17.3500; longitude: 30.2000).

House Fly Maggot Production, Processing and Nutritional Analysis

To produce maggot meal the protocol described by Khan *et al*. (2018) was used. The maggots were allowed to attain optimal size in 3-4 days and then harvested. After harvesting, they were killed in boiling water to kill harmful microorganisms. Then the maggots were oven dried at 75 ^{0}C to constant weight and milled through a 2 mm sieve using a hammer mill. The sample was then taken for proximate analysis at Aglabs in Harare.

Diet Formulation

Feed formulation was done using the IDT Trial and Error (Iteration) Software to produce four iso-nitrogenous and iso-energetic diets at 0%, 5%, 10% and 15% inclusion levels of maggot meal (*Table 1*). Soya meal based (0% maggot inclusion) was used as a positive control diet. Maggot-based multi-nutrient block meal rations were formulated and the results were validated by way of proximate analysis. The nutritional composition of the formulated blocks is represented in *Table 2* and micronutrients in formulated rabbit blocks are shown in *Table 3.*

Table 1: Inclusion levels of feed ingredients in rabbit blocks

Ration	0% maggot meal	5% maggot meal	10% maggot meal	15% maggot meal
Maggot meal	0	5	10	15
Soya meal	22.6	16.7	10.8	5
Wheat bran	18.4	19.3	20.2	20.5
Katambora grass hay	42	42	42	42.5
Molasses	15	15	15	15
Mono-calcium phosphate	0.5	0.5	0.5	0.5
Rock salt	0.5	0.5	0.5	0.5
Vitamin mineral premix	0.5	0.5	0.5	0.5
Limestone flour	0.5	0.5	0.5	0.5

Article DOI: https://doi.org/10.37284/eajab.6.1.1644

Table 2: Nutritional Composition of the Formulated rabbit blocks

Treatment	DM %	CP %	EE %	CF%	M.E/ KG DM	ADF	NDF
0%	89.6	18	1.98	24.6	10.7	15.5	31.2
5%	89.9	18	2.91	24.9	10.9	15.8	31.4
10%	90.1	18	3.83	25.2	11.0	16.1	31.6
15%	90.3	18	4.73	25.5	11.1	16.5	31.8

DM- dry matter percentage, CP- Crude protein, EE-ether extracts, CF -crude fibre, ME- Metabolizable energy per kg dry matter, ADF- acid detergent fibre, NDF- nutrient detergent fibre

Table 3: Micronutrients in formulated rabbit blocks

Treatment	Ca %	P%	Mg%	K%	Na%	Zn/ppm	Se/ppm	Cu/ppm
0	1.3	1.98	0.87	7.83	0.36	42.3	0.04	9.69
5	1.31	2.37	0.86	6.72	0.61	45.4	0.03	10.6
10	1.32	2.76	0.85	5.61	0.87	48.5	0.02	11.5
15	1.34	3.15	0.84	4.54	1.12	51.2	0.01	12.3

Ca*- calcium,* ***P****-phosphorus,* ***Mg****- magnesium,* ***K****- potassium,* ***Na****- sodium,* ***Zn****- zinc,* ***Cu****- copper* **ppm***- parts per million*

Multi-Nutrient Block Preparation

Feed ingredients for each treatment were weighed using a digital scale and thoroughly mixed in a vertical feed mixer so as to achieve a uniform mix. Feed ingredients were conditioned at 20 % moisture content to facilitate blocking. Blocks were produced for each treatment using a plastic frame. During casting, a thin plastic sheet was placed in the moulds to facilitate the removal of the blocks after setting. This prevented the maggot-based multi-nutrient blocks (MNB) from sticking directly to the moulds. The plastic sheet was also used to wrap the blocks, thus preventing loss of moisture and facilitating storage.

After removal of the moulds, blocks were air dried for nine days. The dried MNB were stored in covered plastic pails to safeguard against rodents and insects while avoiding exposure to factors such as high temperature, humidity, and fungal growth.

Experimental Design

The research design that was used is a Complete Randomized Block design to analyse the effect of different inclusion levels (0%, 5%, 10% and 15%) of housefly maggot meal-based diets. Each rabbit weaner was randomly allotted to four different treatments. Each treatment was replicated three times with two rabbits per replicate. The blocking factor was sex.

The experiment was made up of four (4) treatments:

- Treatment 1: 0% maggot meal inclusion level (Control diet)
- Treatment 2: 5% maggot meal inclusion level
- Treatment 3: 10% maggot meal inclusion level
- Treatment 4: 15% maggot meal inclusion level

House Preparation and Animal Management

Twenty-four rabbit weaners of the *Chinchilla giganta* breed (12 males and 12 females) aged six weeks and weighing between 730 grams and 750 g were used. On arrival at the rabbit unit, the rabbits were given stress packs to relieve them from stress they would have been exposed to during transportation. The weaned rabbits were randomly allocated to hutches. Then the hutches were randomly allocated to four experimental dietary treatments, which were 0% maggot meal (control), 5% maggot meal 10% maggot meal and 15% maggot meal. Each treatment was replicated three times with two rabbits per replicate. The

Article DOI: https://doi.org/10.37284/eajab.6.1.1644

experimental design that was used to measure the growth parameters is a Randomized Complete Block Design (RCBD).

A two-week period of acclimatization to the feed and new environment (hutches) before the recording of observations was given to the weaned rabbits. The rabbits were housed individually in wooden hutches of size 1 m x 1 m dimension with wire screen floors attached underneath. The hutches were thoroughly disinfected before stocking. Each hutch was provided with a plastic feeder and a drinker. The hutches were designed to ensure cross-ventilation and exclusion of rodents and other pests. Experimental animals were fed at 0800 hours every day and water was provided ad libitum throughout the experimental period of 8 weeks.

Data Collection

The weight of animals was measured individually using a digital scale.

Carcass Analysis

At the end of the trial, on day 56, three (3) rabbits per treatment were starved for 12 hours and slaughtered for carcass evaluation. Live weight, dressed weight and organ weights were taken using an electronic weighing balance and expressed as a percentage of the live weight of the rabbits.

Statistical Model

A statistical model Randomized Complete Block Design was used for data analysis:

$$Y_{ij}= \mu + T_j+ \beta_j+ \varepsilon_{ij}$$

Where *yij*= response observed on carcass and internal organ weights characteristics of weaned rabbits; μ = Overall mean, an unknown constant.; T*j*=an effect due to treatment *I*, that is, 0%, 5%, 10 and 15%; Bj= an effect due to block *j*, that is, the sex (male and female); Ɛij= random error associated with the response from an experimental unit in block *j* receiving treatment *i*.

RESULTS

Effects of Maggot Meal-Based Diets on Carcass Attributes in Grower Rabbits

Table 4 shows the mean for slaughter and internal organ weights for grower rabbits after eight weeks of feeding on graded levels of housefly maggot (HFM)-based diets. In terms of slaughter weight of the experimental rabbits after eight weeks, differences between the three-housefly maggot-based treatments (5%, 10% and 15%) were cumulative but did not reach statistical significance ($P > 0.05$). The control treatment (0% HFM) produced significantly lower slaughter weights compared to the housefly maggot-based dietary treatments. Results for weights of internal organs indicated increasing kidney and liver weights due to the inclusion of housefly maggot meal in the diet of the rabbits, with dietary inclusion of 15% maggot meal having the highest kidney and liver weights, which significantly differed from the control treatment. The other housefly maggot treatments did not attain significant differences from each other in liver and kidney weights at slaughter. The control treatment had significantly lower slaughter, kidney and liver weights compared to 10% and 15% housefly maggot dietary treatments. There were no differences in heart weights following the four dietary treatments.

Article DOI: https://doi.org/10.37284/eajab.6.1.1644

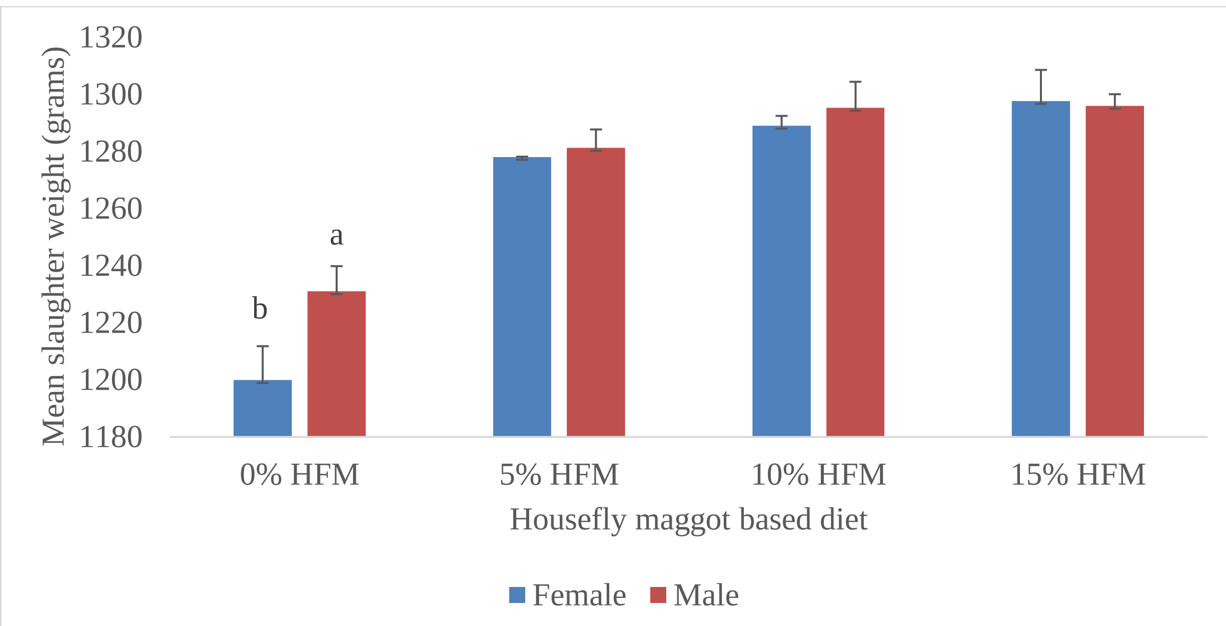
Table 4: Slaughter and internal organ weights (Mean±SD) in grams for grower rabbits fed on graded levels of housefly maggot (HFM)-based diets

Variable	Diet				Sig.	Effect
	0% HFM	5% HFM	10% HFM	15% HFM	(P-value)	size (η_p^2)
Slaughter weight	1,215±23.5[b]	1,280±8.1[a]	1,292±10.9[a]	1,297±12.8[a]	0.000***	0.850
Heart weight	5.07±0.082	5.06±0.089	5.17±0.160	5.20±0.190	0.247[ns]	0.184
Kidney weight	6.10±0.110[b]	6.30±0.212[ab]	6.40±0.216[a]	6.52±0.133[a]	0.004**	0.482
Liver weight	3.95±0.774[b]	4.60±0.485[ab]	4.83±0.415[a]	5.08±0.500[a]	0.013*	0.408

*[abc]Means within the same row with different superscripts indicate significant differences between dietary treatments (Fisher's LSD, P < 0.05). Significance is * P < 0.05; ** P < 0.01; ***P < 0.001; [ns]P > 0.05, not significant.*

There were no statistical differences (*P > 0.05*) between the two sexes in each treatment in all the slaughter variables studied. Results for slaughter weight in relation to sex are given in Figure 2. Males generally had higher finish weights compared to females, though this difference was significant only for the control treatment.

Figure 1: Effect of dietary treatment on slaughter weight of grower rabbits. Error bars indicate SEM



Pearson's correlation analysis showed that all correlations between the carcass traits were positive (*Table 5*). Slaughter weight had a significant and highly positive correlation with liver (R = 0.703, P < 0.001) and kidney (R = 0.630, P < 0.001) weights. The correlation between slaughter weight and heart weight was moderately positive (R = 0.470) and non-significant (P > 0.05). The correlation was also moderately positive and significant between liver and kidney weights (R = 0.441, P < 0.05).

Table 5: Pearson's correlation (P-value) for slaughter and internal organ weight traits of grower rabbits fed on graded levels of housefly maggot meal

	Slaughter weight	Heart weight	Kidney weight
Heart weight	0.369 (0.076)		
Kidney weight	0.630 (0.001)	0.312 (0.137)	
Liver weight	0.703 (0.000)	0.301 (0.153)	0.441 (0.031)

DISCUSSION

Effects of Maggot Meal Diets on Internal Organ Weights

The internal organ weights observed in this study were 5.07-5.20g for the heart, 6.52-6.10g for the kidney and 3.95-5.08g for the liver. Compared to the present study, Abubakar *et al.* (2015) fed *Moringa oleifera* leaf meal to rabbits and reported lower heart weights (2.95-4.10g) and higher liver (40.35-57.05g) and kidney (8.30-10.70g) weights. Like Abubakar *et al.* (2015), other researchers observed an increase in kidney and liver weights with higher dietary inclusion of raw kapok (*Ceiba pentandra*) seed meal (Wafer *et al*., 2017). The findings from these studies may be attributed to the response by the liver and kidney to anti-nutritional factors because of the role that these organs play in detoxification and excretion in the body. Although not tested in this study, higher liver and kidney weights may indicate that housefly maggot meal has higher levels of anti-nutrients.

The development of internal organs and muscular growth in animals depends on nutrition, among other factors (Frandson *et al*., 2009). This study observed that internal organ weights were significantly influenced by the dietary levels of housefly maggot meal. The inclusion level of maggot meal significantly differed in slaughter, kidney, and liver weights but had no effects on mean heart weight. The three experimental diets (5%, 10% and 15% maggot meal) were similar in slaughter weight but were significantly higher than the control diet ($P < 0.001$). Slaughter weight had a high and significant positive correlation with liver and kidney weight. Studies focussing on the effects of housefly maggot meal on internal organ weights in rabbits are not available. Higher values of liver weight with increasing dietary inclusion of maggot meal observed in this study could be an indication of the extent of involvement of this organ in digestion and metabolism (Frandson *et al.,* 2009). A few studies available focused attention on meat quality traits, slaughter, carcass weight and abdominal fat pad rather than internal organ weights. However, internal organ weights have been investigated in poultry feeding. For instance, Téguia *et al.* (2002) reported a higher proportion of the liver and gizzard in broilers fed maggot meal-based diets (included 2.25%, 4.50% and 6.75%) compared to the control group.

CONCLUSIONS

The study found that diets, where 10-15% of housefly maggot meal is included achieved better internal organ weights relative to soya bean meal-based diets. These maggot meal levels represent 50-80% partial replacement of soya bean meal in the diet. Dietary inclusion of 5% housefly maggot meal produced results comparable with those of the soya bean meal-based control diet.

Recommendations

The present study demonstrated that maggot meal has the potential to replace expensive protein ingredients such as soya bean meal in commercial rabbit diet formulation. Dietary inclusions of up to 150 g/kg (50-80% dietary replacement of soya bean meal) are recommended to ensure optimum growth performance and body composition of growing rabbits. However, commercial use of this insect meal as a feed ingredient in rabbit diets would depend on industrial-scale production of the larvae and reduced costs of maggot meal.

Article DOI: https://doi.org/10.37284/eajab.6.1.1644

REFERENCES

Abu, O. A., Onifade, A. A., Abanikannda, O. T. F., & Obiyan, R. I. (2008, June). Status and promotional strategies for rabbit production in Nigeria. In *9th World Rabbit Congress* (pp. 10-13).

Abubakar, M., Ibrahim, U., Yusuf, A. U., Muhammad, A. S. and Adamu, N. 2015. Growth performance, carcass and organ characteristics of growing rabbits fed graded levels of *Moringa oleifera* leaf meal in diets. Bayero *Journal of Pure and Applied Sciences*, 8(2): 7 – 9. http://dx.doi.org/10.4314/bajopas.v8i2.2

Assan, N. (2014). Micro-livestock farming and food security in Sub-Saharan Africa. *J Anim Prod Adv*, *4*, 374-387.

Beinpuo, E. N. (2009). *Strategic innovations in urban agriculture, food supply and livelihood support systems performance in Accra, Ghana*.

Bosch, G., Veenenbos, M. E., Van Zanten, H. H. E., Meijer, N. P., van der Fels-Klerx, H. J., & van Loon, J. J. A. (2018). Efficiency of organic stream conversion by black soldier fly larvae: a review of the scientific literature. *Journal of Insects as Food and Feed*, *4*(supplement 1), S44-S44.

Foley, J. A., Ramankutty, N., Brauman, K. A., Cassidy, E. S., Gerber, J. S., Johnston, M., ... & Balzer, C. (2011). *Solutions for a cultivated planet. Nature*, 478(7369), 337-342.

Frandson, Rowen D., W. Lee Wilke and Anna Dee 2009. Anatomy and physiology of farm animals, 7th Edition. Wiley-Blackwell

Huis, A. Van. (2013). The potential of Insects as Food and Feed in Assuring Food Security. https://doi.org/10.1146/annurev-ento-120811-153704

Khan, M., Chand, N., Khan, S., Khan, R.U., Sultan, A. (2018). Alternative to Soybean Meal in Broiler Ration During ABSTRACT. *Brazilian Journal of Poultry Science*, 9–14.

Mahmood, H. Z., Hussain, I., & Iftikhar, S. (2014). Role of Livestock in Food Security: An Ascertainment from Punjab Pakistan, 4(8), 458–470. https://doi.org/10.6007/IJARBSS/v4-i8/1121

Makinde, O. J., & Makinde, J. (2015). Maggot meal: A sustainable protein source for livestock production-A Review. *Advances in Life Science and Technology. SSN*, 2224-7181.

Makkar, H. P. S., Tran, G., Heuzé, V., & Ankers, P. (2014). State-of-the-art on use of insects as animal feed. Animal Feed Science and Technology, 197, 1–33.

Manyeruke, C., Hamauswa, S., & Mhandara, L. (2013). The effects of climate change and variability on food security in Zimbabwe: A socio-economic and political analysis.

Mekonnen, M. M., & Hoekstra, A. Y. (2013). The water footprint of poultry, pork and beef: A comparative study in different countries and production systems $. Water Resources and Industry, 1–2, 25–36. https://doi.org/10.1016/j.wri.2013.03.001

Meneguz, M., Dama, A., Caimi, C., Gariglio, M., Schiavone, A., Gai, F., & Gasco, L. (2018). Preliminary result of high fibre material impact on growth performance of black soldier fly larvae (Hermetia illucens). In *The 2nd International Conference 'Insects to Feed the World'(IFW 2018)* (Vol. 4, No. Supplement 1)), pp. 31-31).

Molen, P. Van Der. (2016). Food security, land use and land surveyors, 6265(June), 0–6. https://doi.org/10.1080/00396265.2015.1137159

Mupepi, O., & Matsa, M. M. (2021). Spatio-temporal dynamics of drought in Zimbabwe between 1990 and 2020: a review. *Spatial Information Research*, 1-14.

Oonincx, D. G., Van Itterbeeck, J., Heetkamp, M. J., Van Den Brand, H., Van Loon, J. J., & Van Huis, A. (2010). An exploration on greenhouse gas and ammonia production by insect species suitable for animal or human consumption. *PloS one*, *5*(12), e14445.

Owen, O. J., & Dike, U. A. (2013). Japanese Quail (Coturnix coturnix japonica) husbandry: a means of increasing animal protein base in developing countries. *Journal of Environmental Issues and Agriculture in Developing Countries*, *5*(1), 1-4.

Téguia, A.; Mpoame, M.; Mba, J.A.O. 2002. The production performance of broiler birds as affected by the replacement of fish meal by maggot meal in the starter and finisher diets. *Tropicultura* 20, 187–192.

Wafar R. J., Yakubu B., and Lalabe B. C., 2017. Effect of feeding raw kapok (ceiba pentandra) seed meal on the growth performance, nutrient digestibility, carcass and organ weights of weaner rabbits. *Asian Research Journal of Agriculture* 5(3): 1-8. https://doi.org/10.9734/ARJA/2017/33431