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Maggot Meal: A Sustainable Protein Source for Livestock Production-A Review

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Abstract
With a growing world population and increasingly demanding consumers, the production of sufficient protein from livestock, poultry, and fish represents a serious challenge for the future especially, in the developing countries. Maggot, the larvae of the domestic fly (*Musca domestica*) has ability to grow on a large range of substrates and this can make them useful to turn wastes into a valuable biomass rich in protein and fat. Studies have shown that maggot meal has a great benefit as a potential protein source in poultry nutrition and its use as fish and crustaceans feed in pond farming has been studied extensively since the late 2000s. Therefore, mass production of maggot meal must be encouraged as this will offer solution to the high cost of protein feed in fish and livestock production.
Keywords: maggot meal, protein source, livestock production

Introduction

The high rate of increase in world population has made advances in agricultural technology imperative. Dairy, poultry, meat and fish are the main sources of animal proteins, lipids and vitamins which are essential ingredients for human nourishment. It is therefore critical that the animals and fishes be properly reared with complete diets formulated by the combination of essential nutrients in the right proportions (AIFP, 2004).

In developing nations like Nigeria, the cost of commercial livestock farming and fish feeds have become very expensive (Ayinla, 1988) accounting for over 60% of the recurrent overhead costs of livestock farming and about 70% of a fish farming venture (Sogbesan *et al*., 2005). This is due mainly to the fact that most of the protein ingredients such as fishmeal are imported while locally available alternatives like soya beans and groundnut also serve as food for humans.

Several attempts have been made to find inexpensive and relatively abundant nutrient-rich substrates to partially or, even completely, replace these expensive components. Maggots and other non-conventional insects like winged termites, earthworms and garden snails have been explored to check their nutrient contents, relative abundance, use and conversion into processed meals, incorporation into formulated diets and subsequent development of technique(s) for on-farm mass production (Ugwumba and Ugwumba, 2003; Ayinla, 1988). The short life cycle of maggots- the larval stage of flies of the order Diptera (Houseflies- *Musca domestica*) and their production in large biomass (quantity) from materials regarded as waste make them a viable option to explore.

Maggot meal has been reported to be a possible alternative to the expensive protein sources (Sheppard, 2002; Teguia *et al*., 2002; Ogunji *et al*., 2006). Calvert *et al*. (1971) suggested the use of maggots as a replacement source of some key ingredients in feeds and this was further corroborated by Teotia and Miller (1974). It has good nutritional value, cheaper and less

tedious to produce than other animal protein sources. It is also produced from wastes, which otherwise would constitute environmental nuisance. The production system thus serves the dual purpose of providing a nutrient-rich resource as well as a source of waste transformation and reduction. The reported crude protein values range from 43 to 64% (Awoniyi *et al*., 2003; Fasakin *et al*., 2003; Hwangbo *et al*., 2009; Odesanya *et al*., 2011). However, the production system is yet to be commercialized (Teguia and Beynen, 2005) probably because its utility and value as feed ingredients have not been elucidated and so far previous researches on maggots as poultry feed (Dankwa *et al*., 2002; Ekoue and Hadzi, 2000) and fish (Ebenso and Udo, 2003; Madu and Ufodike, 2003) were only done under experimental conditions. Therefore, this paper aims to shed more light on the potentials of maggot meal as suitable protein source in livestock feed.

NUTRIENT COMPOSITION

There is a considerable variation in nutrient composition of maggot meal reported in literature. This variation may not be unconnected with the type of fly attractant and substrate used during production process (Fasakin *et al.,* 2003), processing, drying or storage methods used but studies have shown that maggot meal can be a good source of animal protein in fish and poultry diets. The reported crude protein varied from as high as 64% (Hwangbo *et al*., 2009) to as low as 39.16% (Atteh and Ologbenla, 1993). Table 1 summarizes the nutrient composition of maggot meal as reported by various authors.

Table 1: Nutrient composition of maggot meal

Nutrients, %	A	B	C
Dry matter	92.7	94.78	91.34
Crude Protein	47.1	63.99	39.16
Crude fibre	7.5	-	8.25
Ash content	6.25	5.16	6.15
Ether Extract	25.3	24.31	20.76

A-Aniebo *et al*. (2008), B- Hwangbo *et al.* (2009), C- Atteh and Ologbenla (1993)

Aniebo *et al*. (2008) reported that the proximate analysis showed that maggot meal from substrate mixture of cattle blood and wheat bran harvested on day 3 contained 47.1% crude protein, 25.3% fat, 7.5% crude fiber and 6.25% ash at dry matter level of 92.7%. Also, range of 40-58% crude protein, 21-28% fat, 5-8% crude fiber and 0.56-1.4% ash have been documented for maggot meal (Ajayi, 1998) whereas Olele (2011) showed that maggots have 44.5% crude protein, 10% ash and 24% lipid. Zheng *et al*. (2010) reported on the nutritional values of maggot meal processed with different methods, the authors observed that the moisture level of fresh maggot averaged 74.8% while dry maggot averaged 7.5%. They further reported that crude protein in biomass of fresh larvae and dry larvae ranged from 10.4-18.5% and 55.3-61.2% respectively. These values were relatively higher than those observed in other studies (Odesanya *et al*., 2011). Proximate analysis of maggot meal in a study by Odesanya *et al.* (2011) indicated 86.0 ±0.47% moisture content, 10.03 ± 0.44% ash content, 5.89 ± 0.05% CF, 48.0 CP, 31.76 ± 0.02% crude fat, 3755 ± 190 kcal/kg energy. Fatty acids profile showed lauric acid, palmitic acid, oleic acid and stearic acid to be 69.92%, 2.09%, 15.25% and 12.75%, respectively. Adesulu and Mustapha (2000) reported that the levels of some essential amino acids including cystine, histidine, phenylalanine, tryptophan and tyrosine in maggot meal is higher than in fish meal and soy bean meal. Maggot meal is rich also in phosphorus, trace elements and B complex vitamins (Teotia and Miller, 1973). In addition, Zheng *et al*. (2010) reported that essential amino acids (THR, VAL, LEU, PHE, MET and LYS) accounted for around 48.5% of the total amino acids, while higher percentages of GLU, ASP, and HIS were also found. Table 2 summarizes the amino acid composition of maggot meal as reported by different authors.

Table 2: Amino acid composition of maggot meal

Nutrients, %	A	B	C
Essential amino acids			
Valine	3.61	3.40	2.92
Isoleucine	3.06	3.50	1.46
Leucine	6.35	5.30	5.22
Lysine	6.04	5.20	5.22
Phenylalanine	3.96	4.20	3.57
Methionine	2.28	2.60	2.34
Tryptophan	-	-	3.17
Histidine	3.09	2.60	1.98
Arginine	5.80	4.20	3.63
Threonine	2.03	3.40	2.27
Non-essential amino acids			
Aspartic acid	8.25	8.50	2.21
Serine	3.23	3.20	5.63
Glutamic acid	15.30	10.80	5.71
Proline	2.85	3.10	1.58
Glycine	4.11	3.90	3.27
Alanine	2.86	4.20	4.85
Cystine	0.52	0.40	0.42
Protein (%DM)	47.10	63.10	63.99

A-Aniebo *et al*. (2008), B- Calvert *et al.* (1969), C- Hwangbo *et al.* (2009)

Maggot meal is of high biological value. According to Akpodiete and Ologhobo (1999), maggot meal contains the ten essential amino acids and this is comparable to fish meal (Fetuga, 1977), thus, it has high nutritive value. The percentage of crude protein of 39.55%, lipid 12.5-21% and crude fiber 5.8-8.2% were reported by Ogunji *et al*. (2008a). Ogunji *et al*. (2008b) reported that the biological value of maggot meal was equivalent to that of whole fish meal and that the larvae contained no anti-nutritional or toxic factors sometimes found in alternative protein sources of vegetable origin. Fasakin *et al*. (2003) reported that crude protein content of maggot meals ranged between 43.3% and 46.7% in full –fat sun dried and hydrolyzed /defatted oven dried maggot meals respectively. Thus similar crude protein and lipid values were obtained in processing methods involving sun drying and oven drying either hydrolyzed or defatted maggot meals (Fasakin *et al*, 2003).

UTILISATION OF MAGGOT MEAL IN POULTRY DIETS

The search for alternative and sustainable proteins is an issue of major importance that needs viable solutions in the short term, making maggot meal an increasingly attractive feed option for poultry. Insects are natural food sources for poultry. Chickens, for example, can be found picking worms and larvae from the topsoil and litter where they walk. Maggot meal has been included in broiler diets as a replacement for conventional protein sources, notably fish meal. Most trials indicate that partial or even total replacement of fish meal is possible, though the optimal inclusion rate is generally lower than 10%. Higher rates have resulted in lower intake and performance, perhaps due to a decrease in palatability, as the darker colour of the meal may be less appealing to chickens (Atteh and Ologbenla, 1993; Bamgbose, 1999). The research conducted by Adeniji (2007) indicated that maggot meal could replace 75% and 100% of groundnut oilcake meal in the diets of broilers without adverse effect on dry matter intake. Also, Atteh and Ologbenla (1993) replaced fish meal with maggot meal in a 0-5 week old broilers and reported that maggot meal could replace up to 33% fish meal without adverse effect on intake and weight gain. At higher levels however, lower feed intake was reported. In order to increase the palatability of maggot meal, Bamgbose (1999) suggested that maggot meal should be supplemented with methionine. Also, positive results have been reported on the effect of maggot meal on growth performance and carcass characteristics of broilers. For instance, Hwangbo *et al.* (2009) investigated the effect of maggot meal supplementation on performance of broilers. The authors formulated diets to contain 0% (control), 5%, 10%, 15%, 20% maggot meal respectively and these diets were formulated to be isoenergetic and isonitrogenous with similar lysine and methionine inclusion levels. Broilers receiving diets with maggot meal supplementation at 10 and 15% respectively had significantly higher ($P<0.05$) weight gains than the broilers receiving no maggot meal. The feed conversion ratio was also significantly lower ($P<0.05$) in all the diets supplemented with maggot meal when compared to the control. Hwangbo *et al.* (2009) attributed the differences in weight gain and high crude protein digestibility to the essential amino acid profile of the maggot meal. These differences can also be attributed the fact that the control diet had high levels of maize gluten meal (8%) that could have caused the lower performance (Afshar and Moslehi, 2000). These results differ from the findings of Awoniyi *et al*. (2003), Adeniji (2007) and Teguia *et al*. (2002) who found no significant effect ($P>0.05$) of maggot meal supplementation on weight gain and feed conversion ratio (FCR). Awoniyi *et al*. (2003) replaced fish meal with maggot meal at levels of 25, 50, 75 and 100% respectively with no significant effect on feed intake ($P>0.05$). The effect of maggot meal supplementation is more visible after three weeks of age and this may be due to the difference in which adults and young broiler chickens utilize the maggot meal protein (Awoniyi *et al*., 2003). Furthermore, Teguia *et al*. (2002) studied the effect of maggot meal supplementation in broiler nutrition and its effect on performance and carcass characteristics in the starter, grower and finisher phases. The species of maggot used was not reported though. All the treatment diets were formulated to have similar nutritional values, but the control diet contained no maggot meal. Results showed that there was no significant effect ($P>0.05$) regarding weight gain when 10% of the fish meal was replaced with maggot meal as compared to the control group in the starter phase. This may be attributed to the lower crude protein concentration (22.65%) as compared to the other treatment diets in the starter phase. When 5% and 15% of the fish meal was replaced with maggot meal in the starter phase the weight gain was higher and this effect was found to be significantly better ($P<0.05$). During the finisher phase, Teguia *et al*. (2002) replaced 50% and 100% of the fish meal with maggot meal respectively.

These authors found that there was no significant effect ($P>0.05$) on weight gain when 50% of the fish meal was replaced with maggot meal when compared to the control diet. The weight gain was significantly better ($P<0.05$) when 100% of the fish meal was replaced with maggot meal when compared to the control diet. The overall inclusion levels of maggot meal were, however, very low and ranging between 0.23% and 2%. In a similar study, Okah and Onwujiariri (2012) investigated the effect of replacing fish meal with maggot meal on 0-35day old broilers. Diets were formulated such that maggot meal replaced fish meal at 0, 20, 30, 40 and 50%. The authors reported that maggot meal could replace 50% fish meal with higher performance and economic returns. They also reported that the 25% maggot meal diet yielded better live weights, feed intake and daily gain when compared to the 25% fish meal diet in the growth phase. Furthermore, Cadag *et al.* (1981) compared maggot meal with fish meal, meat and bone meal and soybean meal in a 0-21 day broilers, they reported that maggot meal could be included at up to 10% in the diet with no adverse effect on intake, body weight, feed conversion and palatability. The effect of maggot meal on egg production by laying birds has been extensively investigated by several authors with positive results. In a 7-month layer feeding trial, maggot meal replaced meat and bone meal and the results indicated that maggot meal increased egg yield and hatchability (Ernst *et al*., 1984). Similarly, In 50-week laying hens, maggot meal replaced 50% of fish meal protein (5% diet as fed) without adverse effects on egg production and shell strength. However, 100% replacement was deleterious to hen-day production (Agunbiade *et al*., 2007). Akpodiete *et al.* (1998) investigated the replacement values of maggot meal for fish meal in diet of laying chickens and concluded that maggot meal can nutritionally and productively replace fish meal in layer diet without adverse consequences on performance and egg quality characteristics. The authors also found that egg yolk cholesterol and calcium concentration significantly (P<0.05) declined with increased inclusion of maggot meal in laying chickens' diet, suggesting that the use of maggot meal in poultry diets may reduce cholesterol intake through consumption of eggs. The effect of maggot meal on carcass characteristics of broiler chickens was reported by Teguia *et al.* (2002). They observed that broilers fed maggot meal diets had carcass quality that are similar to the control, the liver and gizzard increased in size, but no signs of toxicity were observed. Indeed, none of the numerous studies on maggots as animal feed has revealed any health problems (Sheppard and Newton, 1999). Also, Awoniyi *et al*. (2003) observed that maggot meal supplementation had no significant influence on dressing percentage and breast muscle weights and this agrees with the findings of Teguia *et al*. (2002), but differs from the findings of Hwangbo *et al*. (2009). This contradictory report could also be attributed to the trial design where Hwangbo *et al*. (2009) had 30 replicates per treatment in relation to the six replicates of Awoniyi *et al*. (2003) and the four replicates of Teguia *et al*. (2002).

UTILISATION OF MAGGOT MEAL IN RABBIT DIETS

Utilization of maggot meal in rabbit diets has not been extensively investigated. Duwa *et al.* (2014) reported that there was a significant (P<0.05) difference in the dry matter intake (DMI) of rabbits. The dry matter intake increased with increasing levels of maggot meal across dietary treatments, with rabbits fed 37.5% and 50% maggot meal having the highest values and those on the control, 12.5 and 25% maggot meal the least. This result is similar to the finding of Abubakar *et al.*(2006) who reported that there were significant differences (P<0.05) in dry matter intake of weaner rabbits fed varying levels of plant protein sources in diets. Duwa *et al.* (2014) reported that there were no significant differences (P>0.05) in the weight of rabbits. They attributed the insignificant difference to the intake of energy and protein which were well above maintenance requirements.

UTILISATION OF MAGGOT MEAL IN PIG DIETS

Information on the use of maggot meal for pig feeding is scarce but the few literatures that available showed that maggot meal is not detrimental to the performance and health status of pigs. For instance, Adeniji (2008) reported that early weaned pigs could tolerate up to 10% of a 3:1 mixture of dried rumen contents and maggot meal in the diet without any adverse effect on performance. Similarly, Viroje and Malin (1989) fed weaned pigs with 10% maggot meal and reported no negative effect on body weight gain and feed conversion efficiency. Also, Bayandina *et al*. (1980) fed sows and their offspring a diet containing processed housefly maggots and reported no adverse effect on piglet performance, health and organoleptic properties or on the sows' physiology and breeding performance.

UTILISATION OF MAGGOT MEAL IN FISH DIETS

There have been numerous experiments on the use of maggots in the diets of African catfish, mostly *Clarias gariepinus*. The results are generally positive though the inclusion of maggot meal should be limited to 25-30% as performance tends to decrease when higher inclusion rates are used. For instance, Ebenso and Udo (2003) fed Nile tilapia fish a 4:1 mixture of wheat bran and live maggots, they reported that the maggot-fed fish had a better growth performance, specific growth rate, feed conversion ratio and survival than fish fed wheat bran alone. Similarly, Sogbesan *et al*. (2006) replaced 0-100% fish meal (0-30% diet) with maggot meal in the diet of *Heterobranchus longifilis* (f) x *Clarias gariepinus* (m) and reported that best growth performance was obtained at 25% replacement (7.5% inclusion). They however observed that 100% replacement (30%) is economically viable.

In another experiments by Ogunji *et al*. (2007), Ogunji *et al*. (2008a) and Ogunji *et al*. (2008b), maggot meal was included at 15 to 68% in the diet, replacing fish meal. The best performance and survival was obtained at 25% maggot meal in the diet. Maggot meal was found beneficial to fish growth and performance with no adverse or stress effect on the haematology and homeostasis was observed. However, the authors suggested that adequate sources of n-6 and n-3 fatty acids should be included in the diet to enhance the optimal fatty acid profile.

The superiority of maggot meal inclusion in fish feed over other animal byproducts was also reported by Adewolu *et al*. (2010) who fed *Clarias gariepinus* fingerlings with 4:3:2 mixture of feather meal, chicken offal meal and maggot meal replacing 0-100% fish meal and reported that maggot meal could replace 50% fish meal (30% diet as fed) without adverse effect on weight gain, specific growth rate, feed conversion ratio, and protein efficiency ratio. They however reported poor performance at 75 and 100% substitution. In another study, Ossey *et al*. (2012) compared the performance of *Heterobranchus longifilis* fed diets containing soybean meal, cattle brain meal and maggot meal included at 80%. The authors reported that Maggot meal gave better performance than soybean meal and lower performance than cattle brains. However, maggot meal was much less expensive than the latter feed. A research on inclusion of differently processed maggot meal was carried out by Fasakin *et al*. (2003). The authors evaluated the growth performance of *Clarias gariepinus* fed diet containing defatted, sun-dried and oven-dried maggot meal replacing fish meal. They reported that fish fed 27% defatted oven-dried maggot meal (27% in the diet) had similar growth performance and survival than fish fed 25% fish meal.

Fashina-Bombata and Balogun (1997) and Ajani *et al.* (2004) showed that the nutritive value of maggot meal compared favourably with that of fish meal. They concluded that maggot meal can replace up to 100% of fish meal in the diets of Nile tilapia (*O. niloticus*).

DISEASES ASSOCIATED WITH MAGGOT MEAL

The housefly is a known carrier of pathogens and the inclusion of maggot meal in livestock diets raises concerns about potential transmission of diseases. Particularly, there is a risk that bacteria or fungi present in the maggot-rearing substrate, which is usually poultry manure, carry over to the finished maggot meal, especially when the keeping quality of the maggot meal is uncertain. However, experiments have not reported contaminations due to feeding maggot meal to poultry or fish. Indeed, none of the numerous studies on maggots as animal feed has revealed any health problems (Sheppard and Newton, 1999). Koo *et al*. (1980) observed no pathological signs associated with feeding maggot based diets to chicks. Bayandina *et al*. (1980) and Poluektova *et al.* (1980) reported that dietary maggot had no adverse effects on health of pigs. In the study carried out by Atteh and Oyedeji (1990), no disease symptom or mortality was observed when maggot meal replaced groundnut cake in broiler diets. Also, Adeniji (2007) reported zero mortality in diets containing maggot meal i.e. 25-100% maggot meal replacing groundnut cake diet implies that maggots have no pathological effect on the chicks. His result agrees with Calvert *et al.* (1969) and Teotia and Miller (1974) who both reported that no pathological changes occurred in chicks fed maggot based diets. All these observations point to the fact that after proper treatment, maggots may either contain a tolerable level of micro organisms or none at all. It was recommended to dry the meal to 4-5% moisture to minimize bacterial activity. After processing, protection from moisture absorption can be achieved by water proof bagging (with cellophane or nylon) and heat-sealing (Awoniyi *et al*., 2004). Generally, care must be taken to assure that adequate heating takes place during the drying process so that any pathogenic organism that were present are destroyed (Rocas, 1983).

CONCLUSION

► It is concluded from this review that maggot meal show great potential as an alternative protein source that can replace conventional protein sources used in animal nutrition. Therefore, its production on a large scale should be encouraged.

► Further research into the utilization of maggot meal in the diets of different classes of animal is necessary as no literature was found on its use in ruminant nutrition.

REFERENCES

Adeniji A.A. (2007). Effect of replacing groundnut cake with maggot meal in the diet of broilers. International Journal of Poultry Science. 6(11): 822-825.

Adeniji A.A. (2008). The feeding value of rumen content-maggot meal mixture in the diets of early weaned piglets. Asian J. Anim. Vet. Adv., 3(2):115-119.

Adesulu E.A. and Mustapha A.K. (2000). Use of housefly maggots as a fishmeal replaces in tilapia culture: A recent vogue in Nigeria. In: K. Ftzimmons and J.C. Filho (Ed.). Proceedings of the Fifth International Symposium on Tilapia Aquaculture. 3–7 September, Rio de Janeiro: 138–143.

Adewolu M. A., Ikenweiwe N. B. and Mulero S. M. (2010). Evaluation of an animal protein mixture as a replacement for fishmeal in practical diets for fingerlings of Clarias gariepinus (Burchell, 1822). Israeli J. Aquacult. - Bamidgeh, 62 (4): 237-244

Afshar, M. and Moslehi, H. (2000). Investigation in the effect of using wheat gluten meal on broiler performance. Agricultural Ministry. Tehran, Iran.

Agunbiade J.A., Adeyemi O.A., Ashiru O.M., Awojobi H.A., Taiwo A.A., Oke D.B. and Adekunmisi A.A.(2007). Replacement of fish meal with maggot meal in cassava-based layers' diets. Journal of Poultry Science. 44(3): 278-282.

Ajani E.K, Nwanna L.C and Musa B.O. (2004). Replacement of fishmeal with maggot meal in the diets of Nile tilapia, *Oreochromis niloticus*.World Aquaculture, 35(1): 52-54.

Ajayi O.O.(1998). Evaluation of full fat/ defatted maggot meal in the nutrition of African catfish, *Clarias gariepinus*. M.Sc. thesis. Akure Nigeria: Federal University of Technology.

Akpodiete, O.J, Ologhobo A.D, Onifade A.A (1998). Maggot meal as a substitute for fish meal in laying chicken diet. Ghana Journal of Agric. Sci., 31: 137-142.

Akpodiete O.J. and Ologhobo A.D. (1999). Biochemical evaluation of Maggot (larvae) meal on the growth and sexual maturity of replacement pullets. Trop. J. Ani. Sci. 1 (2):45-51.

Aniebo A.O., Erondu E.S. and Owen O.J. (2008). Proximate composition of housefly larvae (*Musca domestica*) meal generated from mixture of cattle blood and wheat bran. Lives. Res. Rural Dev. 20 (12).

AIFP (2004). Farming Nigeria's waters: newsletter of the Aquaculture and Inland fisheries Project (AIFP) of the Special Programme for Food Security. Technical Note No. 5, April, 2004.

Atteh J.O. and Ologbenla F.D. (1993). Replacement of Fishmeal with Maggots in Broiler diets: Effects on Performance and Nutrient Retention. Nigerian Journal of Animal Production. 20:44-49.

Atteh J.O. and Oyedeji J.O. (1990). The replacement value of maggots for groundnut cake in broiler diet. Centre point. 10: 39-46.

Awoniyi T.A.M., Aletor V.A. and Aina J.M. (2003). Performance of broiler chicken fed on maggotmeal in place fishmeal. Int'l Journal of Poultry Science. 2 (40): 271-274.

Awoniyi T.A.M., Adetuyi F.C. and Akinyosoye F.A. (2004). Microbiological investigation of maggot meal, stored for use as livestock feed component. J. Food Agric. Envir., 2 (3-4):104-106.

Ayinla O.A. (1988). Nutritive and Reproductive performance of *Clarias gariepinus* (Burchell1822). Unpublished Ph.D thesis, University of Ibadan. Nigeria. 433p.

Bamgbose A.M. (1999). Utilization of maggot meal in Cockerel diets. Indian J. Anim. Sci. 69(12):1056-1058.

Bayandina G.V., Nkiru T.O. and Inkina Z. G. (1980). Effect of prolonged use of housefly larvae in the diets of sows and their offsprings, on the fattening and meat quality of the young pigs. Nutr. Abstr. Rev., 52:355.

Cadag, M.T., Lopez, P.L. and Mania, R.P. (1981). Production and Evaluation of maggot meal from common housefly (*Musca domestica*) as animal feed. Philippine J. Vet. Anim. Sci. 7(1):40-41.

Calvert C.C., Martins R.D. and Morgan N.O. (1969). Housefly pupae as food for poultry. Journal of Economic Entomology, 62 : 938-939.

Calvert C.C., Martins R.D. and Eby H.J. (1971). Biodegraded hen manure and adult houseflies: Their nutritional value to the growing chick. Livestock Waste Management and Pollution Abatement, Proceedings International Symposium on Livestock Wastes, Ohio State University. 319-320.

Dankwa D., Nelson F.S., Oddoye E.O.K. and Duncan J.L. (2002). Housefly larva as a feed supplement for rural poultry. Ghana J.Agric. Sci., 35:185-187.

Ebenso I.E. and Udo M.T. (2003). Effect of live maggot on growth of the Nile perch, *Oreochromis niloticus* (Cichlidae) in south Eastern Nigeria. Global J. Agric. Sci. 2(2):72-73.

Ekoue S.K. and Hadzi Y.A. (2000). Maggot production as a protein source for young poultry in Togo-Preliminary observations. Tropicultura*,* 18(4):212-214.

Ernst L., Vagapov R., Posdeeva E., Zhemchuzhima A. and Zvereva E. (1984). A high-protein feed from poultry manure. Ptitsevodstve, 1:30.

Fasakin E. A., Balogun A. M. and Ajayi O. O. (2003). Nutrition implication of processed maggot meals; hydrolyzed, defatted, full-fat, sun-dried and ovendried, in the diets of *Clarias gariepinus* fingerlings. Aquaculture Research. 9 (34): 733-738.

Fashina-Bombata, H.A. and Balogun O. (1997).The effect of partial or total replacement of fish meal with maggot meal in the diet of tilapia (*Oreochromis niloticus*) fry. J. Prospects Sci.,1: 178–181.

Fetuga B.I. (1977). Animal production in Nigeria and feed supplies. Nig. J. Anim. Prod. 418-421.

Hwangbo J., Hong E.C., Jang A., Kang H.K., Oh J.S., Kim B.W. and Park B.S. (2009). Utilization of house fly-maggots, a feed supplement in the production of broiler chickens. Journal of Environmental Biology. 30(4):609-614.

Koo S.I., Currin T.A., Johnson M.G., King E.W. and Turk D.E. (1980). The nutritional value and microbial content of dry face fly pupae (*Musca autumnalis* (De Geer) when fed to chicks. Poultry Sci. 59: 2514-2518.

Madu C.T. and Ufodike E.B.C. (2003). Growth and survival of catfish (*Clarias anguillaris*) juveniles fed tilapia and maggot as unconventional diets. J.Aquatic., 18(1):47-51.

Odesanya B.O., Ajayi S.O., Agbaogun B.K.O and Okuneye B. (2011). Comparative Evaluation of Nutritive Value of Maggots. Int. J. Sci. Engin. Res., 2(11).

Ogunji J.O., Slawski H., Schulz C., Werner C. and Wirth M. (2006). Preliminary evaluation of housefly maggot meal as an alternative protein source in diet of carp (*Cyprinus carpio* L.) World Aquaculture Society Abstract Data Aqua 2006 - Meeting, Abstract 277.

Ogunji J.O., Nimptsch J., Wiegard C., and Schulz C. (2007). Evaluation of the housefly maggot meal (magmeal) diets on catalase, glutathione S-transferase and glycogen concentration in the liver of *Oreochromis niloticus* fingerlings. Comp. Biochem. Physiol. A, Molecular and Integrative Physiology, 147 (4):942-947.

Ogunji J.O., Kloas W., Wirth M., Schulz C. and Rennert B. (2008a). Housefly maggot meal (Magmeal) as a protein source for Oreohromis niloticus (Linn.). Asian Fisheries Science, 21(3): 319-331.

Ogunji J.O., Kloas W., Wirth M., Neumann N. and Pietsch C. (2008b). Effect of housefly maggot meal (magmeal) diet on the performance, concentration of plasma glucose, cortisol and blood characteristics of *Oreochromis niloticus* fingerlings. J. Anim. Physiol. Anim. Nutr. 92(4): 511-518.

Okah, U. and Onwujiariri, E. B. (2012). Performance of finisher broiler chickens fed maggot meal as a replacement for fish meal. J. Agri. Technol., 8(2): 471-477.

Olele, N.F. (2011). Comparative study on the use of natural and artificial based feeds for the culture of *Clarias gariepinus* Fingerlings.Asian Research Publishing Network. J. Agri. Biol. Sci., 6: 9-13.

Ossey Y. B., Koumi A. R., Koffi K. M., Atse B. C. and Kouame L. P. (2012). Use of soybean, bovine brain and maggot as sources of dietary protein in larval *Heterobranchus longifilis* (Valenciennes, 1840). J. Anim. Plant Sci., 15 (1): 2099-2108

Poluektova L.S, Chaplinskaya K.N, Dement'eva T.A, Kozlova L.S. and Ganenkova N.M. (1980). Effect of adding into the diet of pigs a meal from house-fly larvae on metabolism, development, and meat quality of the pigs. Nauchnye Trudy Novosibirskogo Sel'skokhozyaistvennogo Instituta. 128: 24-27.

Rocas R.C. (1983). Improved utilization of poultry manure in broilers through maggot (*Musca domestica*) production. Thesis, University of the Philippines at Los Banos, College, Laguna.

Scholtz C.H. and Holm E. (1985). Insects of Southern Africa. Butterworths Durban.

Sheppard C. (2002). Black soldier fly and others for value – added manure management. University of Georgia, Tifton G.A.31794, USA. http://www.virtualcentre.org/en/enl/vol1n2/article/ibs_conf.pdf.

Sheppard C. and Newton L.(1999). Insect Digestion of Manure. *In* Lorimor J 2002. Manure management white paper written for the National Center for Manure and Animal Waste Management. AWARE v7.n1.

Sogbesan O.A., Ajuonu N.D., Ugwumba A.A.A, and Madu C.T. (2005). Cost benefits of maggotmeal as supplemented feed in the diets of *Clarias gariepinus* x *Heterobranchus longifilis* hybrid fingerlings in outdoor concrete tanks. J. Sci. and Ind. Stud. 3 (2): 2005.

Sogbesan A. O., Ajuonu N., Musa B. O. and Adewole A. M. (2006). Harvesting techniques and evaluation of maggot meal as animal dietary protein source for "Heteroclarias" in outdoor concrete tanks. World Journal of Agricultural Sciences 2 (4): 394-402.

Teguia A., Mpoame M. and Okourou Mba J. A. (2002). The production performance of broiler birds as affected by the replacement of fish meal by maggot meal in the starter and finisher diets. Tropiculture. 4: 187-192.

Teguia A. and Beynen, A.C. (2005). Alternative feedstuffs for broilers in Cameroon. Livestock Research for Rural Development 17 (3) 2005.http://www.lrrd.org/lrrd17/3/tegu17034.htm.

Teotia J.S. and Miller B.F. (1973). Fly Pupae as a dietary ingredients for starting chicks. Poultry Science, 53: 1830-1835.

Teotia J.S. and Miller B. F. (1974). Nutritive content of housefly pupae and manure residue. British Poultry Science. 15: 177-182.

Ugwumba A.A.A. and Ugwumba A.O. (2003). Aquaculture Options and future of fish supply in Nigeria. The Zoologist 2(2): 96-122.

Viroje W. and Malin S. (1989). Effects of fly larval meal grown on pig manure as a source of protein in early weaned pig diets. Thurakit Ahan Sat, 6 (21): 25-31.

Zheng W. Dong Z. Wang X.Q. Cao M., Yan B.L., and Li S.H. (2010). Effects of dietary fly maggot (*Musca domestica*) on growth and body compositions in Chinese shrimp *Fenneropenaeus chinensis* juveniles. Fisheries Science (Dalian), 29 (4): 187-192.

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