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Maggot Production Using Selected Substrates and Attractants and Its Utilization as Replacement for Fishmeal in Diet of *Clarias gariepinus*

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ABSTRACT: Fish feed account for over 70% of the total cost of fish production, this is due to the high cost of its components most especially fishmeal which is highly expensive and imported. Trials to replace costly fishmeal in fish diets with maggot meal have shown promising results. However, wide use of maggot meal in aquaculture feed industry is limited due to unavailability of adequate amounts of maggot meal. Therefore, this study was carried out to determine the best possible substrates and attractants combination for production of housefly larvae. Also the study examined the growth performance and nutrient utilization of *Clarias gariepinus* juveniles fed the produced maggot meal as an alternative to the fishmeal in their respective diet. Maggot production experiment was laid out as a 3 substrates (brewer's waste, poultry droppings and cow dung) by 3 attractants (Kitchen waste, spoilt fruits and abattoir waste) factorial in a complete randomized design (CRD). Each treatment was replicated three times. A total of twenty-seven (27) units was used for the project. While for the fish trial the experimental design consist of five (5) dietary treatment with three (3) replicates each. Diet 1 with 0% maggot meal (MGM) inclusion served as control; diet 2 (25% MGM), diet 3(50% MGM), diet 4 (75% MGM) and diet 5(100% MGM). The result show that the best substrate for maggot production among the selected substrate was brewer's waste (76.06 g/kg) abattoir waste, (65.62 g/kg) kitchen waste and (58.55 g/kg) spoilt fruit while the best fly attractant among the tested attractants was abattoir waste (76.06 g/kg) brewer's waste, 31.48 g/kg (poultry waste) and 19.18 g/kg (cow dung). Thus, for maggot production, a combination of brewer's waste and abattoir waste was recorded as the best in terms of quantity of maggot produced. *C. gariepinus* fed with diets containing maggot meal as a replacement for fishmeal. It was observed the diet containing 50% of maggot meal and 50% fishmeal recorded the best value for mean weight gain (3.29 g), feed intake (2.99 g), feed conversion ratio (1.34), relative weight gain (13.74) and specific growth rate (1.88). Therefore, for optimum production of *C. gariepinus*, maggot meal inclusion level should be limited to 50%. The study has clearly demonstrated that some selected substrates can be fully utilized in the production of *Musca domestica* larva for fish feed formulation.

Keywords: Maggot meal, *Musca domestica*, Fish feed, *Clarias gariepinus*

Introduction

Nutritionally, fish is about the cheapest and direct source of protein and micro nutrients for several millions of Africans (Bene and Heck, 2005). It provides 40% of animal protein consumption in Nigeria and it is also a very important source of animal protein for livestock in developed and developing countries (Ozigbo *et al*, 2014). In Nigeria, fish demand as estimated by Ruma (2008), was 2.1 million metric tons at 11.5 kg per capita consumption with domestic production from the wild estimated at 5% leaving a gap of 41% which is about four times the level of local production.

Once fish are removed from their natural environment to an artificial one, nutritive food must be supplied in order to enable them grow (Aliu *et al.,* 2016). This could be in the form of complete rations, where the artificial diet furnishes all the nutrients required by the fish or supplementary diets, where part of the nutritional needs of fish is supplied by the natural food in the aquatic environment (Eyo, 2003). Both intensive and semi-intensive fish culture systems involve input of supplementary and complete feed, which account for up to 40% and 60% of production costs respectively (Fagbenro *et al,* 2003) and can sometimes negate the economic viability of a farm if suitable feed are not used. This problem has become a major source of fear and phobia to many prospective fish farmers in Nigeria and urgent solution must be proffered if fish farming is to be attractive, lucrative and sustainable (Madu *et al.,* 2003). The major item in recurrent cost in fish production is feed. This item alone has progressively taken the larger shares of costs of production (Balogun *et al,* 1992*).* Carefully compounded feed when fed at the recommended level (rate) are usually backed by the manufacturer's guidance to meet the nutrients requirements of physiologically defined farm animals for a sustainable level of production (Falayi, 2003). The principal cost in manufacture of compound feed is that of raw materials. This could amount to as much as 80 percent or more, of the manufacturing costs in large size mills. Due to increasing transportation costs and the need to conserve foreign exchange, the tendency in most developing countries will be to use locally available ingredients (Aliu *et al,* 2016).

The use of insects as animal feed is increasingly promoted as a replacement for other, less sustainable animal protein sources such as fishmeal (Henry *et al.,* 2015). Among insects, fly larvae are particularly promising because they can be produced cheaply and rapidly on organic waste material (Pastor *et al.,* 2015). The fly species and the production system depend on the geographic context and the targeted business model. Nowadays, large industrial production systems of black soldier fly, *Hermetia illucens*, larvae are promoted, based on the rearing of adult flies in captivity and the insemination of eggs into suitable substrates (Pastor *et al.,* 2015). The house fly, *Musca domestica* L., is also considered both for manure management (Roffeis *et al.,* 2015) and as a replacement for fish meal in poultry and fish feed (Adeniji, 2007).

Houseflies (*M. domestica*) are the most diverse group of flies, capable of turning decaying organic matters into nutritionally rich food of animal origin. They are easy to produce and process and relatively cheaper than other sources of animal protein (Aliu and Owiredu, 2012). Maggots can grow on various organic wastes such as pig dung (Pastor *et al.,* 2015), cattle blood and wheat bran, poultry manure (Hwangbo *et al.,* 2009), cattle gut and rumen content. The maggots are nutritious with 10.2% moisture, 56.3% crude protein, 22.3% crude fat and relatively high amounts of micronutrients. However, wide use of maggot meal in aquaculture feed industry is limited due to unavailability of adequate amounts of maggot meal.

Materials and methods

Study location: The study on maggot production was carried out at the Department of Aquaculture and Fisheries Management farm site in the University of Benin, Benin City, Edo State of Nigeria, located on latitude 60360N and longitude 060190E in the humid rainforest region of Southern Nigeria. The choice of this location was to take the research away from residential area due to foul odours that emanate from decaying attachments and subtracts. The culture of experimental fish was also carried out in the same location. Annual temperature ranges between 1498 mm – 3574 mm with a mean of 2430 mm relative humidity and daily sunshine ranges between 63.31 - 81.71% (with a mean of 73.5%).

Experimental layout for maggot production: The experiment was laid out as a 3 substrates (brewer's waste, poultry droppings and cow dung) by 3 attractants (kitchen waste, spoilt fruits and abattoir waste) factorial in a complete randomized design (CRD). Each treatment was replicated thrice. A total of twenty-seven (27) units was used for the project.

Experimental procedure for maggot production: Maggots for this experiment was cultured according to methods described by Madu and Ufodike (2003). A total of 2 kg of each of the substrates was mixed with 0.2 kg of fly attractant and placed randomly in triplicates in culture units. The units were exposed for 8 h to attract houseflies to naturally lay their eggs (oviposition). The substrates were then covered with perforated black polythene sheet to provide darkness. The substrates were kept moist by sprinkling water once daily. Harvesting was done morning and evening from the fourth day. The collection was done as described by Sogbesan *et al.* (2006) using screen nets. Maggots are photonegative, so in an attempt to escape from the traces of sunlight, they passed through the 3mm mesh size net and was collected into a basin under the net. Each substrate was placed in an air tight container overnight to neutralize any fly eggs or larvae that could be present at the time of collection.

Substrates: The substrates used in this study include:

- Brewers waste, sourced from Guinness Nigeria Plc. Depot located in Ramat Park, Benin City.
- Poultry droppings, sourced from Garry's Poultry Farms Ltd. located in Ekehuan Road, Benin City and
- Cow Dung, sourced from an Abattoir located at Evbotubu Road, Benin City.

Attractants: The attractants used include

- Kitchen waste, sourced from restaurants along Ekehuan Road, Benin City.
- Spoilt fruits, sourced from markets within Ekehuan axis, Benin City and
- Abattoir waste, sourced from an abattoir along Evbotubu Road, Benin City.

Preparation of experimental diet for culture fish

Experimental diets: fishmeal, yellow maize, bone meal and vitamin premix were brought from retail outlet in Benin City, Nigeria. Each experimental design consist of five (5) dietary treatment (Table 1) with three replicates each. Diet 1 with 0% MGM inclusive serves as control; Diet 2 (25% MGM); Diet 3(50% MGM), Diet (75% MGM) and Diet 5 (100%MGM). In preparing the diets, ingredients were milled mixed and prepared as described by Martinez-Palacios *et al*. (1996). The milled ingredients were then sieved through standard sieve Nos. 16 and 20 (maximum of 1.19 mm). The homogenously mixed feed was processed into pellets (2 mm) with gelatinized corn starch component as the binder. After preparation, pelleted diets were oven-dried at 100 °C for 5 h. Feed samples were then stored in polythene bags in a cupboard at laboratory temperature at 7 °C. Dried granules of feed samples were taken for proximate analysis. All ingredients were locally sourced for the trials conducted.

Experimental fish: *Clarias gariepinus* of initial weight 8.00±0.5 g was obtained from the Hatchery Unit, Department of Aquaculture and Fisheries Management, University of Benin, Benin City.

Experimental procedures for culture fish: The juveniles were fed crumbled 2.00 mm size pellet of experimental diets twice daily to satiation between 8.00- 9.00 hrs and 15.00-16.00 hrs GMT. Feeding was monitored for each unit to ensure that fishes will not be underfed or overfed. Experimental units were cleaned daily while changing of total water, weighing of fish (g) and fed was done weekly. Weekly weight and feed consumption was monitored for twelve weeks.

Experimental procedures for maggot production: Harvesting of maggot was done from the fourth day ensure full body size larva are obtained before transformation into pupa, after which they were weighed and recorded.

Statistical analysis: Data obtained from the feeding trials were analyzed using the computer software Genstat Version 8.1 (2005). Completely randomized design in a one-way ANOVA was used to calculate the mean. The differences in mean were compared using Duncan's multiple range tests at 5% significant level.

Table 1: Gross composition of the experimental diets (%) on as fed basis

Ingredients	**Diet 1 (0% MGM)**	**Diet 2 (25% MGM)**	**Diet 3 (50% MGM)**	**Diet 4 (75% MGM)**	**Diet 5 (100% MGM)**
Fishmeal (65.5% CP)	32.00	24.00	16.00	8.00	0.00
MGM (47.1% CP)	0.00	8.00	16.00	24.00	32.00
SBC (48.0% CP)	35.36	35.36	35.36	35.36	35.36
Yellow maize (9.5% CP)	20.00	8.00	16.00	24.00	32.00
Palm Oil	8.00	8.00	8.00	8.00	8.00
Bone meal	4.00	4.00	4.00	4.00	4.00
Vitamin premix	0.60	0.60	0.60	0.60	0.60
Vitamin E gel	0.04	0.04	0.04	0.04	0.04
Total	100	100	100	100	100

MGM= Maggot meal, SBC= soya bean cake, CP= Crude protein

Parameters monitored for culture fish: Data on the quantity of feed consumed by the fish as well as weight gained by the fish was collected each weekly for each unit for which the following performance was evaluated (Bagenal, 1978).

- Weight Gained (WG) = W2-W1 $_{(g)}$
- Feed intake = Initial weight of feed – Final weight of feed
- Relative Weight Gain (RWG%) = (W1–W0) / W0 × 100
- Specific Growth Rate (SGR) % = {(In W1 –In W0)/ T} × 100
  where: W0: mean initial weight (g), W1: mean final weight (g), T: time in 7 days between weighing, ln = natural logarithm.
- Feed Conversion Ratio (FCR)= feed intake (g) / weight gain (g)
- Protein Efficiency Ratio (PER)= weight gain (g) / protein intake (g)
- Net Protein Utilization (NPU) = {(BP1–BP0)/ CP} × 100.
  where: BP0: Initial body protein content (g), BP1: Final body protein content (g), CP: Protein intake (g)
- Survival rate (SR %) = $\frac{\text{Total number of fish harvested}}{\text{Total number of fish stocked}} \times \frac{100}{1}$

Results

Maggot production using selected substrate and attractants: The results of maggot production using selected substrate and attractants is shown in Table 2. The results showed that in all the three substrates (brewers waste, poultry waste and cow dung) tested in this trial, brewers waste recorded the highest quantity of maggot produced, which had 76.06 g/kg abattoir waste attractant, 65.62 g/kg kitchen waste attractant and 58.55 g/kg spoilt fruit attractant; while the least quantity of maggot produced was recorded in cow dung substrate which had 19.18 g/kg abattoir waste, 10.26 g/kg kitchen waste and 8.14 g/kg spoilt fruit. ANOVA showed that there was significant difference (P<0.05) among all the treatments.

Table 2: Mean weight (g) of maggot produced

Substrates	**BW**			**PW**			**CD**			
Attractants	**AW**	**KW**	**SF**	**AW**	**KW**	**SF**	**AW**	**KW**	**SF**	**SEM**
	76.06^{a}	65.62^{b}	58.55^{c}	31.48^{d}	20.61^{e}	19.15^{f}	19.18^{f}	10.26^{g}	8.14^{h}	0.43

Values with same superscript on the same row are not significantly different (P>0.05)
BW: Brewer's waste, PW: Poultry waste, CD: Cow dung, AW: Abattoir waste, KW: Kitchen waste, SF: Spoilt fruits, SEM: Standard error of means

It was also observed from the results that abattoir waste was the best attractant among the three attractants tested, with 76.06 g/kg, 31.48 g/kg and 19.18 g/kg for brewers waste, poultry waste and cow dung substrates respectively. This was followed by kitchen waste with 65.62 g/kg, 20.61 g/kg and 10.26 g/kg for brewers waste, poultry waste and cow dung substrates respectively. The least performing attractant was spoilt fruit with values of 58.55 g/kg, 19.15 g/kg and 8.14 g/kg for brewers waste, poultry waste and cow dung waste respectively. ANOVA showed that there was significant difference (P<0.05) among all the treatments.

Table 3: Growth performance and nutrient utilization of *Clarias gariepinus* fed diet containing maggot meal

	T1 (0%)	**T2 (25%)**	**T3 (50%)**	**T4 (75%)**	**T5 (100%)**	**SEM**
Weight (g)	2.11^{b}	2.65^{ab}	3.29^{a}	2.25^{ab}	2.14^{b}	0.49
Feed intake	2.71^{ab}	2.97^{b}	2.99^{b}	2.87^{ab}	1.92^{a}	0.46
Feed conversion ratio	1.67^{b}	1.38^{b}	1.34^{b}	1.52^{b}	2.37^{a}	0.31
Protein Efficiency ratio	11.69^{ab}	9.26^{b}	10.27^{ab}	15.20^{ab}	16.75^{a}	3.30
Relative weight gain (RWG)	9.47^{a}	11.45^{a}	13.74^{a}	10.57^{a}	9.86^{a}	2.30
Specific Growth Rate (SGR)	1.05^{a}	1.14^{a}	1.88^{a}	1.68^{b}	1.05^{a}	0.35

N.B: Values with same superscript on the same row are not significantly different (P>0-05)

Weight gain: The mean weight gain increased with increase in inclusion of maggot meal as replacement of fishmeal up until 50% replacement level after which the weight gain reduced with increase in inclusion of maggot meal in the diet. The result showed that the highest mean weight was recorded in Diet 3 (3.29g); this is followed by Diet 2 (2.65g) while the least mean weight gain (2.11g) was recorded in the control Diet. ANOVA showed that Diet 3 was significantly differently (P<0.05) from Diets 1 and 5. These diets were not significantly different (P>0.05) from each other. Diets 2 and 4 were not significantly different from other diets.

Feed Intake: The result of the intake followed similar trend like that of the weight gain. The feed intake increased gradually from Diet 1 and Diet 3 but declined in Diet 4 and Diet 5. The highest feed intake value (2.99g) was recorded in Diet 3 with 50% replacement level; this was followed by Diet 2 with feed intake value of 2.97g. The least amount of feed consumed (1.92g) was recorded in diet 5 with 100% maggot replacement level. There was no significant difference (P<0.05) between Diet 2 and Diet 3 while both diets were significantly different (P<0.05) from Diet 5. There was no significant difference (P>0.05) between Diets 1 and 4 and other diets.

Feed conversion ratio: The feed conversion ratio improved with increase in inclusion of maggot meal as replacement of fish meal up till 50% replacement level after which the feed conversion ratio declined with increase in inclusion of maggot meal in the diet. The results showed that the best feed conversion ratio was recorded in Diet 3 (1.34); this was followed by Diet 2 (1.38) while the worst feed conversion ratio (2.37) was recorded in Diet 5. ANOVA showed that there was no significant difference (P>0.005) between Diet 1, 2, 3 and Diet 4. However, Diet 5 was significantly different (P<0.05) from all other diets.

Protein Efficiency ratio: The result of the Protein Efficiency Ratio is shown above and it showed an irregular trend. However, the protein efficiency ratio increased gradually from Diet 2 - Diet 5 but declined from Diet 1-Diet 2. The highest protein efficiency value (16.75) was recorded in Diet 5 with 100% replacement level, this was followed by Diet 4 with protein efficiency value of 15.20. The least protein efficiency ratio (9.26) was recorded in Diet 2 with 25% maggot replacement level. There was no significant difference (P>0.05) between

Diet 1, Diet 3 and Diet 4. Diet 2 was significantly different ($P<0.05$) from Diet 5 but were not significantly different from other diets.

Relative weight gain: The main relative weight gain increased with increase in inclusion of maggot meal as replacement of fishmeal up until 50% replacement level after which the relative weight gain reduced with increase in the diet. The result showed that the highest mean relative weight gain was recorded in Diet 3 (13.74g), this was followed by Diet 2 (11.45g) while the least mean relative weight gain (9.47g) was recorded in control Diet. ANOVA showed that there was no significant difference ($P>0.05$) among all the diets.

Specific growth rate: The result of the specific growth rate showed similar trend like that of the relative weight gain. Specific growth rate increased gradually from Diet 1 to Diet 3 but declined in Diet 4 and Diet 5. The highest specific growth rate value (1.88) was recorded in Diet 3 with 50% replacement level; this was followed by Diet 4 with specific growth rate value of 1.68. The least amount of specific growth rate (1.05) was recorded in Diet 1 and Diet 5 with 0% and 100% maggot replacement level respectively. There was no significant difference ($P>0.05$) between Diet 1, Diet 2 and Diet 5 while they were significantly different ($P<0.05$) from Diet 3, Diet 4 was not significantly different ($P>0.05$) from other diets.

Discussion

The result showed that Treatment 1 which comprised of brewer's waste as substrate and abattoir waste as attractant produced the highest mean weight of maggot produced (76.06 g/kg). This result is in line with those of Hwangbo *et al.* (2009) who showed that the addition of 10% of fresh bovine blood in rumen content in swine dung and in the mixture of both improves on the biomass of maggots produced but Mafwila *et al.* (2019) reported that the addition to the growth substrates of ingredients that appeared to be more balanced in amino acids (cow blood or manure) or that provide specific otherwise deficient amino acids (lysine) to brewer's grain allowed doubling the production of maggots as well-known for other more conventional single stomached domestic animal species such as pigs or poultry (Pérez and Sauvant 2004). Pig manure has been reported to improve production on Brewer's waste probably due to the presence of bacteria from the digestive tract of pigs that are also rich in essential amino acids, among which is lysine (Metzler *et al.,* 2005; Dai *et al.,* 2010). Interestingly, the combination of brewer's waste and cow blood was able to sustain the highest levels of maggot production in the report of Mafwila *et al.* (2019) and this is similar to the findings of this study. It was also observed from the result that abattoir waste was the best attractant among the three attractant tested. Abattoir waste as attractants recorded 76.06 g/kg, 31.48 g/kg and 19.18 g/kg for brewers waste, poultry waste and cow dung substrate respectively while the least quantity of maggot produced was recorded in cow dung substrate. This difference could probably be due to the fermentation and odour which is a significant attractant for female house flies (Tang *et al.,* 2016). Bouafou, (2011) reported that pig manure is among the most suitable substrates for fly larvae production. Cow, rabbit and sheep manures were cited as less attractive for flies. These substrates have a lower ammonia content due to the quality of feed eaten by the animals and release less putrefying odours. It is a well-known fact that ruminant manures alone are poor substrates for producing fly larvae because of their low nutritional value and, especially, their low protein content (Mpoame *et al.,* 2004; Koné *et al.,* 2017). However, they can be used in mixture with highly attractive and nutritious substrates such as blood or fish offal (Koné *et al.,* 2017).

The progressive mean weight gain of *C. gariepinus* recorded in all the dietary treatment throughout the duration of the experiment is an indication that the fish responded positively to all the diets in terms of growth, and that the protein contents of the experimental diets was likely adequate for growth of the fish. The results obtained from this present study showed that fish fed 50% maggot meal inclusion diet had the best growth performance; an indication that they were able to convert their food into body growth than those on all the other diets. This results are in accordance with that recorded by Omoruwou and Edema (2011), and Ajani *et al. (*2004), who recorded the highest weight gain in 50% maggot meal inclusion in the diet of '*Heteroclarias*' and *O. niloticus* fingerlings respectively. This also agreed with report of Ogunji *et al. (*2008), who observed a better performance of diet containing maggot meal over those fed 100% fish meal.

The growth and nutrient utilization parameters were better in the diet containing 50% maggot meal and 50% fish meal. This may not only be due to higher feed protein and liquid but also the quality of the crude protein and fatty acid composition. Fish meal has been found difficult to be completely replaced in the diet of fish because of the quality of its essential amino acids combination (Dasuki *et al,* 2014). The results obtained in the study are in contrast to the total replacement of fishmeal with sun-dried maggot meal reported by Fasakin *et al,* (2003). Michael and Sogbesan, (2015) also reported that a combination of fishmeal and maggot meal and maggot meal performed better compared to other treatment that involved total replacement of fishmeal with either maggot meal, single-cell protein or a combination of the two.

The result of the evaluated growth and nutrients utilization indices among the five treatments also implied that maggot meal can successfully replace the entire fishmeal portion of the fish diet. Other authors have observed a better performance of fish fed diets containing maggot meal over those solely fed on fish meal diet (Ogojin *et al.,* 2006). This is a reflection of the nutritive quality and acceptance of this biomaterial. The results also corroborate previous observations that maggot meal, like other animal protein sources was well accepted and utilized by fish (Idowu *et al.,* 2003). It has been suggested that the good growth and nutrient utilization capacity of fish fed on maggot based diet stem from the high biological value such as nutrient composition and digestibility of the ingredients (Sogbesan *et al.,* 2006). Jhingram (1983), reported that maggots are easily digested by fish and this has been attributed to its relatively high fiber content, which according to Fagbenro and Arowosoge (1991) plays a significant role in feed digestion. The improving growth response observed with increasing level of maggots, may also be caused by the high level of crude protein in maggot meal.

The feed conversion ratio improved with increase in inclusion of maggot meal as replacement of fishmeal up until 50% replacement-level after which the feed conversion ratio declined with increase in inclusion of maggot meal in the diet. This could possibly be indicative that both protein sources compared favorably in feed to flesh conversion. It has been reported that the biological value of maggot meal is equivalent to that of whole fish meal (Ajayi *et al.,* 2004). This fact is strengthened by the results obtained in the present study.

The highest protein efficiency value (16.75) was recorded in diet 5 with 100% replacement level, this was followed by diet 4 with protein efficiency value of 15.20. The least protein efficiency ratio (9.26) was recorded in diet 2 with 25% maggot replacement level. There was no significant difference ($P>0.05$) between Diet 1, Diet 3 and diet 4. Diet 2 was significantly different ($P<0.05$) from diet 5 but were not significantly different ($P>0.05$) from other diet. This is in contrast to the report by Atteh and Ologbenla (1993) who stated that amino acid profile of maggot meal is similar to that of fish meal and meat meal with a positive linear effect on the fish body protein (Adebayo and Quadri 2005). Bene and Heck (2005) have also reported that maggot oil is high in desirable medium-chain and mono-unsaturated fatty acids, and rich in phosphorus, trace elements and B complex vitamins. Ogunji *et al.,* 2006) postulated that several other ingredients of animal origin such as feather meal, poultry byproduct meal and also plant protein sources may not successfully replace fish meal in aqua feeds due to their inferior amino acid profile, and nutrient inhibition factors found in the latter class.

The mean related weight gain increased with increase in inclusion of maggot meal as replacement of fishmeal up until 50% replacement level after which the relative weight gain reduced with increase in inclusion of maggot meal in the diet. This observation is at variance with those obtained by Samuel and Nyambi (2013) who reported that growth is proportional when fish meal is totally replaced by that of maggots. However, these obtained values are similar with the results of Ezewudo *et al.* (2015). For these authors, the growth performance of fish is better when the fish meal is replaced by maggot meal at a rate of 50% in a diet based on fish meal.

Conclusion

The study clearly demonstrated that some selected substrates can be fully utilized in the production of *Musca domestica* larva for fish feed formulation. The best among the selected substrates for maggot production is brewer's waste while the best fly attractant among the tested attractants was abattoir waste. Thus, for maggot production, a combination of brewer's waste and abattoir waste was seen as the best in terms of quantity of maggot produced.

It was observed that *C. gariepinus* fed with diets containing 50% of maggot meal and fishmeal recorded the best value for weight gain, feed intake, feed conversion ratio, relative weight gain as well as specific growth rate. Therefore, for optimum production of *C. gariepinus* maggot meal inclusion level should be limited to 50%.

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