ISSN No:-2456-2165

Effect of Substrate and Rearing Period on the Yield and Quality of Housefly Larvae ((*Musca Domestica*) as Protein Ingredient in Fish Diets

Kakuru JB[1,3], Semwanga Nathan[3], Kasigwa Howard[2], Kirunda Halid[2] ,Kemigabo Chloe[12]#
[1]Nkumba University, Faculty of Sciences, Department of Fisheries
[2]National Agricultural Research Organisation (NARO), Department of Aquaculture, Mbarara ZARDI
[3]Fisheries Training institute; Department of Aquaculture

Abstract:- To identify a suitable substrate to enhance sustainable access to affordable quality feed protein in Uganda, growth performance and nutritional composition of housefly larvae grown on three common substrates; cow dung (CD) chicken manure (CM) and brewery waste (BW) for 5 days was determined. Eighteen bags were randomly filled with one kilogram (1000g) of each of the three substrate in six replicates were allowed to attract adult housefly that deposited eggs whose larvae were harvested on the 3rd, 4th, and 5th day. The weight of larvae was 43.72 for CM, 39.65 for BW and 33.91 for CD. The crude protein ranged from 45.38-44.21 for CD, 48.60-53.0 for CM and 46.24-50, 32 for BW and significantly differed among substrates (p<0.05) with the highest recorded in chicken manure (CM). On the other hand, the crude protein was significantly high in larvae nourished with Chicken manure (CM) and lowest in cow dung (CD) crude fat did not significantly differ. Results from the study indicated that culturing housefly larvae on chicken manure for 3 days post egg laying offers higher biomass and nutritional quality protein than using cow dung and brewery waste.

Keywords:- *Housefly larvae, local substrates, weight: nutrient composition.*

I. INTRODUCTION

The world is faced with increased demand for protein for human and animal consumption. Fisheries and aquaculture make a vital contribution towards meeting the global demand for quality protein and contribute up to 17% of the global population's intake (FAO, 2017). However, fish production from capture fisheries has dwindled due to over-exploitation, climate change, bad fishing practices and environmental destruction. To bridge the gap in aquaculture characterized by human intervention has increased as an alternative to sustaining demand for fish.

Fish farming brings into play use of artificial feeds with high protein content (25-50%). High protein makes the costs of dietary protein sources in Africa a real challenge to development of fish farming. Fishmeal and soya bean has been the conventional protein sources that constitute 60–75% of the total cost of feed production. The high costs of fish meal and oil seeds especially soybean are enhanced by competition from humans and other animals/livestock and poultry (Dedeke, et al, 2013; FAO, 2017) .Fish farmers have tried to make on-farm feeds that are protein deficient but have not broken even due to poor fish growth that negatively which affects production and profits. (Mwanja, 2013; MAAIF 2020).

This research targeted enhancing production of housefly larvae using low cost locally availed substrates as an alternative and sustainable protein-rich and environmentally friendly feed resource to support small scale fish farmers. The housefly is endemic to Africa and if produced in a controlled environment, can be a sustainable feed resource.

A. The objectives of the study were to:

- determine the effect of rearing period (time) on the yeild of housefly larvae produced from brewery wastes, chicken droppings and cow dung
- to determine the proximate nutrient content of housefly larvae reared on brewery wastes, chicken droppings and cow dung.

The research was based on two hypotheses; Hoi) the weight and length of housefly larvae harvested is significantly influenced by the time/length of rearing and the Hoii) the substrate type used in production of housefly larvae significantly affects their proximate nutrient composition

II. MATERIALS AND METHODS

A. Study Area

The study was conducted at the Fisheries training Institute in Entebbe, with in a veranda of the Wet laboratory during December 2020.

B. Experimental designed

The complete randomized experimental design was used to allocate /raise housefly larvae on three substrates (cow dung (CD), brewers waste (BW) and chicken manure (CM) in six replicates each. Random allocation of treatments to the 18 substrate samples was reached at using the table of random numbers.

C. Statistical analysis

Data was subjected to analysis of variance (ANOVA) from the overall mean using GenStat statistical software version 14.1 GenStat 64-bit Release 14.1 (PC/Windows) 06 July 2011 11:44:46 Copyright 2011, VSN International Ltd). Statistical significances was declared at 95% level of confidence (P<0.05).

III. RESULTS

A. *The effect of rearing period (time) on the yield of housefly larvae produced from brewery wastes, chicken droppings and cow dung*

The weight of housefly larvae harvested significantly differed among substrates ($p<0.05$) with the highest weight recorded in chicken manure (CM) across all the three days of harvest (D3-D5) (Table 2). Although there was observed increase in weight of the housefly larvae with increase in rearing days, the gain did not significantly differ with rearing days among all substrates (Table 2)

Significantly longer housefly larvae were recorded in chicken manure (CM) substrate on all the days ($P \leq 0.05$) . The length of the larvae was in all cases lowest in cow dung (CD) and did not significantly differ along rearing days (Table 3).

B. *The proximate nutrient content of housefly larvae reared on brewery wastes, chicken droppings and cow dung.*

Crude fat and crude protein significantly varied across substrates and days of harvesting ($P<0.05$) with the highest values recorded in larvae nourished with Chicken manure (CM) across all days (Table 4). On the other hand ash (indigestible matter) was highest in larvae raised on cow dung (CD). Dry matter differed among substrates and days of harvesting larvae with the highest recorded in larvae raised on cow dung except for larvae harvested on the 4th day where significantly high dry matter was recorded in Brewers waste.

The mean ash was highest in larvae raised on cow dung substrate and lowest in brewery waste while crude fat and crude protein was higher in larvae raised on chicken dung and brewers waste (Table 4)

IV. DISCUSSION OF RESULTS

A. *The effect of rearing period (time) on the yield of housefly larvae produced*

The interaction of time and substrate affected the larvae output Table 2. Trends show weight and length of houseflies larvae harvested significantly differed among substrates ($p<0.05$) across all three days of harvest (Day3-Day 5). The weight and length of the larvae harvested increased with the increasing rearing period being highest on the fifth day.

Similar results were got by (Hezron et al,2019) under semi-natural conditions where the yield increased with the length of culture with the highest wet yield observed at five days of culture and the least after three days of culture. The scenario was explained by (Hussein et al., 2017; Ukanwoko, Olalekan, & State, 2015) that increasing wet yield of maggots observed from the 3rd day to 5th day of maggot development, is due to the gradual accumulation of larval biomass over time through the whole feeding process. Similar observations were reported by (Liu et al., 2017) when they assessed metabolic changes in the nutritional composition of black soldier fly from egg to adult. However, in this study, it was interesting to note that the weight of housefly larvae from BW reduced with increase in rearing time. This could be attributed to nutrient depletion by 4th day in the substrate. Brewery waste is a good source of energy but is deficient in several amino acids to support the growth of maggots as showed by (Mussatto et al, 2006) and (Mafwila et al., 2019).

B. *The proximate nutrient content of housefly larvae.*

The proximate composition of housefly larvae raised on different substrates in this study differed significantly except generally for crude fat. Chicken manure had the highest crude protein, dry matter and ash but lowest crude fat.

High crude protein was similarly reported in studies by (Gadzama & Ndudim, 2019; Uushona et al, 2020) .The crude protein content of the larvae observed in this study is comparable to maggot flour meal and fish meal protein observed by Hussein et al (2017). Protein is the major growth promoting factor in feed. Studies on fish nutritional requirements show that most fish depending on age, require mainly feed with 25-45% crude protein (Craig, 2017). Maggots from all the three substrates provided the required level of crude protein for use as feed protein sources. However, maggots from poultry waste recorded a higher level of mean crude protein (51.41%) thus presenting as an excellent source of protein for fish compared to the rest.

The mean crude fat content of the larvae in the current study (26.13%) falls within range 24.43 % reported by (Hussein et al 2017) and 10-26% by Steven Craig (2017). This could be attributed to different nutritional content of substrates used. However it falls in the recommended range for fish nutrition. The highest content of crude fat recorded in larvae raised from chicken manure was attributed to the high fat content in the chicken manure due to its less efficient digestion as described in all monogastrics animals unlike the ruminants like cattle.

Ash content in this study was higher in CD (18.61 ± 0.99) than CM and BW. This was close to observations of (Obeng, et al, 2015) who reported lower ash content in CM (8.5%) and a higher content in cow dung (24.25%)

The high content of ash (indigestible matter) recorded in cow dung was attributed to the highly lignified feed type/grass diet utilized by cows. The high percentage of ash recorded in cow dung followed by chicken manure and least in Brewers waste (Table 4) was attributed to the highly ligninified grass diet mainly consumed by cows.

There was observed increment of crude fat content with increase in rearing days while crude protein reduced with increasing growth (rearing days). The content of crude protein was thus highest in larvae samples harvested on the 3rd day of rearing than in the 4th and 5th day. The content of crude protein was negatively correlated to the ash; as the ash increased, crude fat and protein reduced. This implied that indigestible matter took up space that would accommodate useful nutrients like protein. These observations are similar to those observed in black solder fly larvae raised at the National Aquaculture Research Station (Kajjansi ARDC) lead by Anyu Margret (personal communication). The more the days of rearing, the more lignified the larvae got due to development of a cuticle that is indigestible and therefore present as ash.

However, the results on crude protein demonstrated that housefly larvae have a good nutritional profile closer to that of fish meal and thus show great potential as an alternative protein source that can replace conventional protein sources used in animal nutrition.

V. CONCLUSIONS

From this study, it can be concluded that using chicken manure to rear housefly larvae provides better yield/biomass (weight) than brewers waste and cow dung. Housefly larvae harvested on the third day of rearing (3rd day) is of better nutrient quality (low ash, high crude protein) than that harvested later. The study results support the null hypothesis for the first objective and the alternative Ha) for the second objective as follows.

Hoi) The weight and length of housefly larvae is not influenced by the time/length of rearing, and Haii) that the chicken manure substrate type used to nourish housefly larvae significantly enhanced their nutritional quality (proximate nutrient composition) than brewers waste and cow dung

VI. RECOMMENDATIONS

Production of housefly larvae should be conducted using chicken manure and harvesting be done on the third day after laying on the eggs should be promoted for adoption for higher yield and nutritional value as protein feed ingredient in fish feeds

REFERENCES

[1.] Craig, S. (2017). Understanding Fish Nutrition , Feeds , and Feeding. (K. David D & M. H.Schwarz,Eds.), 420–256.

[2.] Dedeke, G., Owa, S., Olurin, K., Akinfe, A., & Awotedu, O. (2013). Partial replacement of fish meal by earthworm meal (Libyodrilus violaceus) in diets for African catfish, Clarias gariepinus. *International Journal of Fisheries and Aquaculture*, 5(9), 229–233. Retrieved from https://doi.org/10.5897/IJFA2013.0354

[3.] FAO. (2017). *The future of food and agriculture Trends and challenges*. Rome.

[4.] Gadzama, I. . ., & Ndudim, R. . (2019). Nutritional Composition of Housefly Larvae Meal : A Sustainable Protein Source for Animal Production – A Review. *Acta Scientific Agriculture 3.4*, 3(4), 74–77.

[5.] Hezron, L., Madalla, N., & Chenyambuga, S. W. (2019). Mass production of maggots for fish feed using naturally occurring adult houseflies (Musca domestica). *Livestock Research for Rural Development 31*, 31(4), 1–11.

[6.] Hussein, M., Pillai, V. V, Goddard, J. M., Park, H. G., Kothapalli, S., Ross, D. A., … Selvaraj, V. (2017). Sustainable production of housefly (Musca domestica) larvae as a protein-rich feed ingredient by utilizing cattle manure, 1–19. Retrieved from https://doi.org/10.1371/journal.pone.0171708

[7.] Liu, X., Chen, X., Wang, H., Yang, Q., Rehman, K., Li, W., … Zheng, L. (2017). Dynamic changes of nutrient composition throughout the entire life cycle of black soldier fly. *PloS One*, 1–21.

[8.] Mafwila Kinkela, P., Bwabwa, D., Nyongombe, N., Kambashi, B., Mafwila, J., Dochain, D., … Rollin, X. (2019). Optimization of ho production on pig wastes and brewers' grains for integrated fish and pig farms in the tropics. *Livestock R Rural Development (Print*, 31(2), 212363.

[9.] Mussatto, S. I., Dragone, G., & Roberto, I. C. (2006). Brewers' spent grain: generation, characteristics and potential applications. *Journal of Cereal Science .43*, 43(1), 1–14. Retrieved from https://doi.org/https://doi.org/10.1016/j.jcs.2005.06.001

[10.] Obeng, A. K., Atuna, R. A., & Aihoon, S. (2015). Proximate composition of housefly (Musca domestica) maggots cultured on different substrates as potential feed for Tilapia (Oreochromis niloticus). *International Journal of Multidiscplinary Research and Development*, 2(5), 102–103.

[11.] Ukanwoko, A. I., Olalekan, O. A., & State, R. (2015). Effects of Source and Time of Harvest on the Proximate Composition of Maggot (Musca Domestica) Larva Meal. *International Journal of Livestock Research ISSN*, 5(7), 84–90. Retrieved from https://doi.org/10.5455/ijlr.20150713102839

[12.] Uushona, T., Simasiku, A., & Petrus, N. P. (2020). Evaluation of Musca domestica (House fly) larvae production from organic waste Evaluation of Musca domestica (House fly) larvae production from organic waste. *Welwitschia International Journal of Agricultural Sciences Vol.*, 1(January 2019), 35–40. Retrieved from https://doi.org/10.32642/wijas.v1i0

List of Tables

Substrate	Crude fat	Dry matter
Probability; P	<0.001	<0.001
Mean	2.43	36
BW	2.81a	9.84c
CD	1.28b	15.40b
CM	3.20a	82.96a
Lsd	0.46	1.05

Table 1: Nutrient composition of the three substrates used to raise Housefly larvae (Brewers waste (BW), Cow dung (CD) and Chicken manure (CM)

Substrate	**Weight harvested(g)**		
	Day3 (D3)	**Day4 (D4)**	**Day5(D5)**
P	<0.001	<0.001	<0.001
Mean	38.5	39.18	39.29
Brewers Waste (BW)	38.5^{b}	39.97^{b}	40.48b
Cow dung (CD)	32.68^{c}	34.30^{c}	34.15c
Chicken manure (CM)	44.65^{a}	43.27^{a}	43,23a

Table 2: Weight (g) of housefly larvae harvested from the substrates over the three days of harvesting

Substrate /day	**Total length(mm)**		
	Day3 (D3)	**Day4 (D4)**	**Day5(D5)**
P	<0.001	0.052	0.004
Mean	11.54	11.71	11.72
Brewers Waste (BW)	11.05^{b}	11.32^{b}	11.47^{b}
Cow dung (CD)	10.67^{b}	11.15^{b}	11.15^{b}
Chicken manure (CM)	12.92^{a}	12.67^{a}	12.53^{a}
LSD	1.09	1.32	0.76

Table 3: Mean individual total length of housefly larvae harvested by type of substrate

	Ash	**Crude fat**	**Crude Protein**	**Dry Matter**
P	0.07	0.005	0.002	0.105
Mean	15.13	26.63	51.41	86.79
CM3	13.47^{b}	25.19^{b}	53.60^{a}	87.47^{a}
CM4	15.92^{a}	26.38^{b}	52.03^{a}	87.36^{a}
CM5	16.01^{a}	28.32^{a}	48.60b	85.54^{a}
LSD	2.41	1.41	1.84	2.05
	0.22	0.002	<0.001	<0.001
	13.48	26.16	48.08	88.49
BW3	13.34^{a}	24.55^{c}	50.32^{a}	87.67^{b}
BW4	13.38^{a}	26.36^{b}	48.02^{b}	92.43^{a}
BW5	13.73^{a}	27.57^{a}	45.90^{c}	85.36^{c}
LSD	0.53	1.17	1.o9	0.59
	0.0344	0.01	0.661	0.468
	18.61	25.6	45.23	89.55
CD3	16.50^{a}	23.69^{c}	45.38^{a}	88.98^{a}
CD4	19.28^{a}	25.30^{b}	46.12^{a}	89.88^{a}
CD5	18.04^{a}	27.80^{a}	44.21^{a}	89.78^{a}
LSD	1.91	0.77	5	1.83

Table 4: Nutrient composition of larvae harvested from the three substrates