Zootechnical performance of *Cyprinus carpio* fry in unfertilized ponds fed a local feed formulated with Musca domestica larvae flour.

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Abstracts

Objective: this study on the effect of the level of incorporation of Musca domestica maggot flour on some zootechnical performances of *Cyprinus carpio* fry in unfertilized ponds.

Study design: The study took place at the Laboratory of Aquaculture and Demography of Fisheries Resources (LADRHa) in the Yabassi District, Nkam department, coastal region and duration 2 months.

Methodology: 375 *Cyprinus carpio* fry with an average weight of 1.73±0.13g were used. After reception and acclimatization for two days. Five food rations were formulated T_{0+} (coppens), T_{0-} without maggot flour and three other food rations T25, T30 and T35 were formulated from the basic ration T_{0-} by incorporating 25%, 30%, 35% maggot flour. The fry were distributed in 15 circular basins of 40L each and a diameter of 395mm in a completely redomized device and repeated three times, installed in an unfertilized pond of 200m^2 fed by a water retention dam. Each happa contained 25 fry. The fry were fed manually, 02 times per day at 10% of their ichthyo biomass until the end of the experiment. Control fishing was carried out every fourteen days.

Results: The survival rate was significantly higher ($p<0.05$) with the T_{0-} treatment and low with the T_{35} treatment. The highest average weight was recorded with the T_{0+} treatment (coppens) and the lowest with the treatment containing 35% maggot meal. Daily weight gain was high with the T_{0+} (coppens) treatment and lower with T_{35}. The specific growth rate was higher with the T_{0+} (coppens) treatment and lower with the T_{30} treatment. The consumption index was lower with the T_{0+} treatment (coppens) and higher with the T_{35} treatment.

Conclusion: It emerges from this study that the fry of *Cyprinus carpio* nouris fed feed containing 25% of *Musca domestica* maggot meal recorded higher zootechnical performances compared to those fed feed containing 30 and 35%.

Key words: Level of incorporation, *Musca domestica* flour, *Cyprinus carpio* fry, unfertilized pond

INTRODUCTION

Faced with one of the greatest challenges of our century, namely, feeding more than 9 billion people by 2050 in a context of climate change, economic and financial uncertainty and fierce competition around natural resources with a deficit with more and more fishery products from capture fisheries [1], the development of aquaculture appears to be an imperative both for developed countries and for those in the process of developing whose undernourishment constitutes a permanent threat. Global fish production reached approximately 179 million tons in 2018, with a total first-sale value valued at US$ 401 billion, of which 82 million tones (US$250 billion) came from aquaculture production. Of this total, 156 million tons were used for human consumption, equivalent to an estimated annual supply of 20.5 kg per capita. The remaining 22 million tons were used for non-food purposes, mainly to produce fishmeal and fish oil. Food insecurity is one of the major problems for many African countries [2]. In Sub-Saharan Africa, fish covers on average 22% of protein needs. In certain countries and notably in Cameroon, this offer would be close to 50% [3], [4] and [5]. Aquaculture production increased from 5213.9 tons in 2018 to 9078.2 tons in 2019, an increase of 74%. In 2019, the volume of seafood imports was 185,829 tones. This production deficit compensated by imports; created a shortfall of approximately 129968 million CFA francs in the trade balance [6]. To remedy this and thus make available to the population fishery products whose breeding conditions do not raise any suspicion, it is imperative to develop the national fish farming sector. The development of this requires that a certain number of prerequisites be respected, namely not only the qualitative and quantitative availability of fry and broodstock, but above all the development of a sector of local production of high-performance feed at reduced cost that can meet the nutritional needs of farmed species, in particular *Cyprinus carpio* which is one of the fish with good aquaculture potential in Cameroon, thanks to its flesh highly appreciated by consumers, its hardiness and its rapid growth. Aquaculture feed is a major factor to consider in the cost of production. Animal waste is widely used for fish production in ponds with very convincing results. For example, in certain regions of Viet Nam, fish farming recycles nearly 77% of livestock effluent, mainly consisting of pig manure [7]. Furthermore, examples suggest that animal feed made from insect meal is comparable to that made from fish meal [8]. In the context of valorization of products and by-products for the production of local feed, a study was carried out on the effect of the incorporation of maggot flour from the house fly on some zootechnical performances of the Common carp.

MATERIALS AND METHOD

Study zone

The study took place in the Yabassi District, Nkam Department, coastal region of Cameroon, more precisely at the Laboratory of Aquaculture and Demography of Fisheries Resources (LADRHa) of the Institute of Fisheries Sciences located.

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Biological material

***Cyprinus carpio* fry and *Musca domestica* larvae meal**

The present study was carried out over a period of 2 months with the aim of determining the optimum level of use of house fly flour in the local feed on some zootechnical performances (final average weight, weight gain daily, the specific growth rate, the consumption index) of *Cyprinus carpio* fry. 375 *Cyprinus carpio* fry with an average weight of 1.73±0.13g obtained in the GIC AIO fish farm in Batie were used. These carpillons, after transport in packaging in 50l drums filled ¾ with water, were received and distributed according to the different regimes. The stocking density was twenty-five carpillons per basin.

The housefly larvae were reared locally and the breeding substrate was pig manure collected from the LADRHa pig farm, the Institute of Fisheries Sciences located. The larvae were collected, dried in an oven and analyzed before incorporation into the fry feed.

Table 1 : Bromatological composition of maggot flour

Chemical composition analyzed	Maggot flour
Proteins	43,65±6,61
Lipids	19,00±4,36
Carbohydrates	57,60±7,59

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Experimental rations

To evaluate the influence of the optimum level of incorporation of maggot meal into the local feed, an imported positive control feed T_{0+} (coppens) was purchased on the local market, four isoprotein rations at 40% protein based of local ingredients have been formulated. A negative control ration T_{0-} was formulated and three other rations were formulated from the feed T_{0-} by substituting fish meal at 25, 30 and 35% in the feed with maggot meal.

Treatment T_{0+} (coppens): fed with imported feed Coppens;

Treatment T_{0-}: fed local feed containing 0% maggot flour;

Treatment T_{25}: fish meal replaced at 25% by maggot meal;

Treatment T_{30}: fish meal replaced at 30% by maggot meal;

Treatment T_{35}: fish meal replaced at 35% by maggot meal.

Table 2: Percentage composition of experimental feeds

Ingrédients	T_{0-}	T_{25}	T_{30}	T_{35}
Fishmeal	40	30	27	24

Corn flour	10	8	8	7
Cassava flour	2	2	2	2
Maggot meal	0	25	30	35
Cotton cakes	0	0	0	0
Peanut cakes	10	10	9	8
Soya four	20	10	10	10
Palm kernel cake	0	0	0	0
Wheat four	7	2	1	0
Shellfish meal	1	1	1	1
Premix 5%*	5	5	5	5
Complexe lys-meth	3	5	5	6
Palm oil	2	2	2	2
Total	100	100	100	100
Analyzed chemical composition of different feeds				
Proteins	39,25±6,27	40,09±6,34	39,04±6,25	40,25±6,34
Lipids	7,70±2,78	5,54±2,35	5,78±2,40	7,65±2,77
Carbohydrates	40,80±6,39	43,31±6,58	49,68±7,05	42,80±6,54
Energie (kcal/kg)	330,60±18,19	315,96±17,78	496±22,27	399,60±19,99

*Premix 10%; Metabolizable energy = 2078 Kcal/Kg; Crude protein = 40%; Lysine = 3.3%; Methionine = 2.40; Calcium = 8%; Phosphorus = 2.05%.

Once the ingredients were purchased, they were individually crushed in a mill to obtain a fine powder. The ingredients were weighed individually according to the different required proportions and mixed manually. The final product was dried and packaged in bottles.

375 *Cyprinus carpio* fry were used for 56 days and distributed in triplicate in 15 circular basins of 40L each (395mm in diameter) at a rate of 25/m and fed at 10% of their biomass twice a day (7:30 a.m. and 5:30 p.m.) with diets distributed as follows:

Experimental design

Fifteen (15) 40L circular basins (diameter 395 mm) were installed in a 200m2 unfertilized pond fed by a water retention dam. 375 fry were distributed in triplicates in 5 treatments of 75 individuals with an average weight of 1.73±0.13g following a completely randomized design. Each replicate contained 25 fry.

Conduct of the test

Once the carpillons were distributed among the different treatments, they were left to acclimatize for 2 days before the start of feeding which lasted 56 consecutive days. The carpillons were fed every day at a frequency of 2 times/day (7:30 a.m. and 5:30 p.m.) at the rationing rate of 10% of the total biomass. Once every 14 days, a control fishing was carried out. For this purpose the size of the carpillons were measured using the ichthyo meter and their weight using a 1g sensitivity scale. The physicochemical parameters were recorded every day using a “Hanna” brand multiparameter

Zootechnical parameters and characteristics studied

Statistical analyzes

The collected data on survival, average weight, average weight gain, daily weight gain, feed efficiency, specific growth rate, were subjected to one-way analysis of variance (ANOVA). Duncan's multiple test at the 5% significance level was applied when differences existed using SPSS Version 20.0 software. (Statistical Packages of Social Sciences).

Results

Variation of some physicochemical parameters of water.

A number of water quality parameters, such as water temperature and pH were measured every 14 days during the study period.

Temperature variation

Temperature is one of the most important factors in water that influences the growth, feed intake, reproduction, and other biological activities of aquatic organisms.

Figure 1 shows that during the study period and regardless of the study period and time of day, temperatures vary between 26°C and 29°C. The highest temperatures (28.74°C ± 0.01 °C) were recorded at the age of 56 days and the lowest (26.5°C ± 0.09 °C) was recorded on the 28th day of the test.

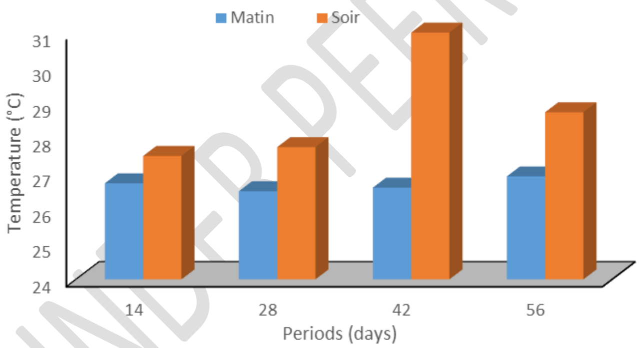


Figure 1: Variation of temperatures depending on the study period

pH variation

Figure 2 shows that the pH of the water varied from 6.69 to 8.03±0.01. The highest pH was recorded at the age of 42 days in the evening and the lowest Ph (6.69 ± 0.01) was observed during the first period of 14 days in the morning.

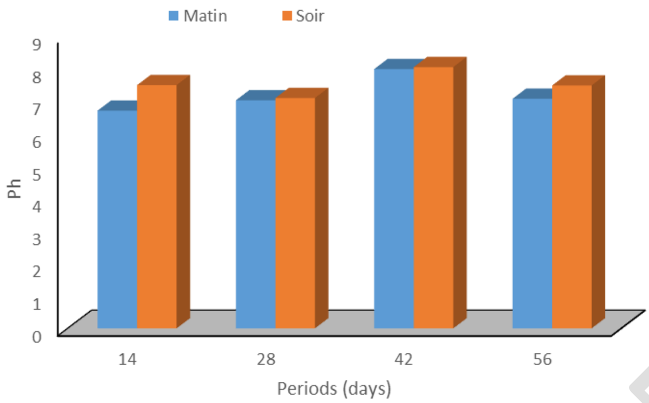
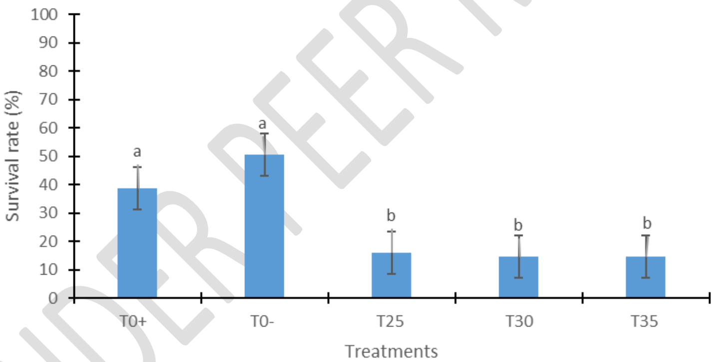


Figure 2: Variation of Ph depending on the study period

Survival

Figure 3 illustrates the variation in the survival rate of carpillons depending on the level of incorporation of *Musca domestica* larvae flour.



(a, b): ($p > 0.05$), histograms with the same letter are not significantly different. T_{0-} = Feed without maggot flour; T_{25}=Feed containing 25% maggot flour; T_{30}=Feed containing 30% maggot meal; T_{35}=Feed containing 35% of d=day maggot meal

Figure 3: Variation in the survival rate of Cyprinus carpio fry depending on the treatments.

From this figure 3, we see that the significantly higher survival rates (p 0.05) were recorded with the subjects fed the control feed without maggot flour (T0-) followed by the treatment fed the imported feed. Furthermore, the fry fed on feed containing

25%, 30%, 35% of maggot meal recorded significantly low survival rates (p 0.05) but comparable to each other.

Zootechnical performances

Table 3 presents some growth performances of *Cyprinus carpio* fry fed on a feed formulated based on *Musca domestica* larvae flour.

Table 3: Effect of the rate of incorporation of *Musca domestica* larvae into feed on some zootechnical performances of *Cyprinus carpio* fry.

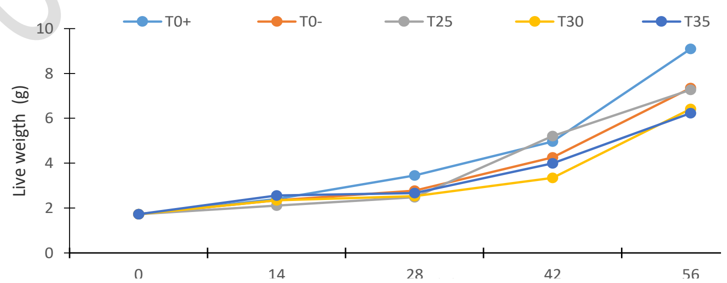
Paramètre	**T_{0+}**	**T_{0-}**	**T_{25}**	**T_{30}**	**T_{35}**	*P*
IW	1,73±0,13	1,73±0,13	1,73±0,13	1,73±0,13	1,73±0,13	
SR	38,66±18,16[a]	50,66±6,11[a]	16,00±8,00[b]	14,66±6,11[b]	14,66±6,11[b]	0,02
AW	9,00±1,00	7,33±0,57	7,66±1,52	6,66±0,57	6,00±1,00	0,39
AWG	7,33±0,57	5,33±0,57	5,66±1,52	4,66±0,57	4,66±1,52	0,63
DWG	0,52±0,040	0,38±0,040	0,40±0,10	0,33±0,40	0,33±0,10	0,63
FCR	1,00±00	2,00±00	1,33±0,57	2,33±0,57	2,33±0,57	0,13
SGR	2,93±0,17	2,52±0,18	2,76±0,39	2,14±0,16	2,33±0,41	0,46

(a, b): p< 0.05, values with different letters on the same line are significantly different.
IW=Initial Weight; SR=Survival Rate; AWG=Average Weight; AWG=Average Weight Gain; DWG=Daily Weight Gain; FCR = Feed conversion ratio; SGR= specific growth rate; T_{0-} = Feed without maggot flour; T_{25}=Feed containing 25% maggot flour; T_{30}=Feed containing 30% maggot meal; T_{35}=Feed containing 35% of d=day maggot meal; p=probability.

Regardless of the parameter studied, the analysis of variance noted no significant difference between the treatments over the entire trial period. However, the highest values were recorded with subjects fed imported feed (T_{0+}) followed by feed containing 25% maggot meal (T_{25}) whatever the parameter considered.

Average weight

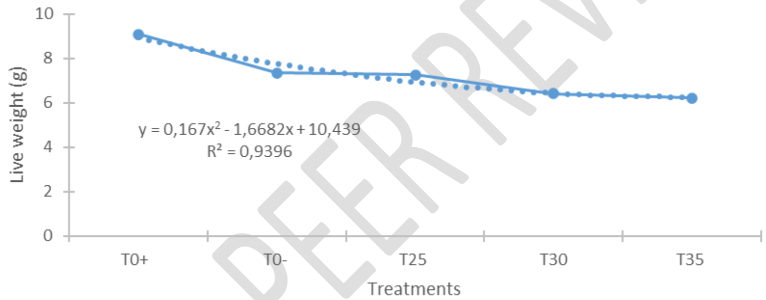
Figure 4 illustrates the daily evolution of the average weight of *Cyprinus carpio* fry depending on the level of incorporation of maggot meal from the house fly *Musca domestica* into the feed.



T_{0-} = Feed without maggot flour; T_{25}=Feed containing 25% maggot flour; T_{30}=Feed containing 30% maggot meal; T_{35}=Feed containing 35% of d=day maggot meal.

Figure 4: Biweekly evolution of the average weight of *Cyprinus carpio* fry fed on feed formulated with maggot flour

From this figure, we observe an increasing and regular evolution of the curves of the different treatments. The curve of treatments fed with imported feed having recorded the highest value ($p > 0.05$) of 9.00±1.00g at 56 days of testing. The curves of the treatments fed with feed containing T_{30}; T_{35} respectively 6.66±0.57g; 6.00±1.00g) of maggot flour remained below the other curves at 56 days of testing. From Figure 5 we can observe that the incorporation of maggot meal at increasing levels into the diets of *Cyprnus carpio* fry leads to a regression in the weight of the fish.

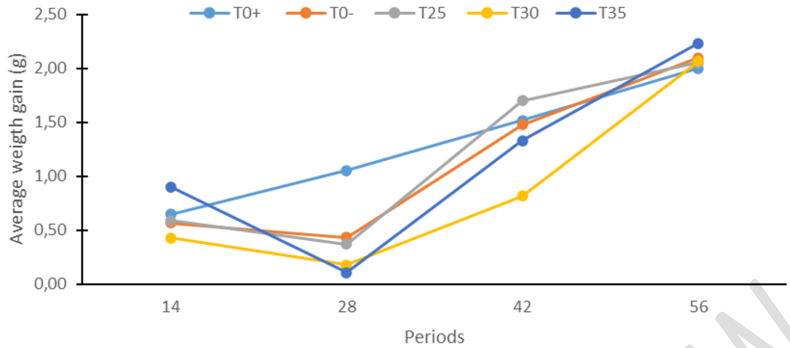


T_{0-} = Feed without maggot flour; T_{25}=Feed containing 25% maggot flour; T_{30}=Feed containing 30% maggot meal; T_{35}=Feed containing 35% of d=day maggot meal

Figure 5: Regression of live weight according to the rate of incorporation of maggot meal into the feed of *Cyprnus carpio* fry

Daily weight gain

Figure 6 illustrates the evolution of the daily weight gain of *Cyprinus carpio* carpillons as a function of the level of incorporation of maggot meal from the housefly *Musca domestica* into the experimental food.



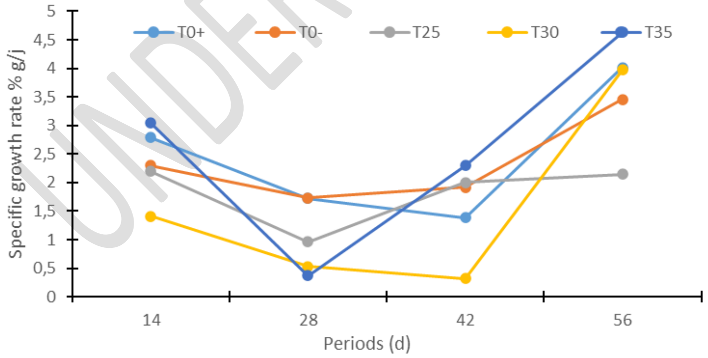
T_{0-} = Feed without maggot flour; T_{25}=Feed containing 25% maggot flour; T_{30}=Feed containing 30% maggot meal; T_{35}=Feed containing 35% of d=day maggot meal

Figure 6: Evolution of daily weight gain as a function of time.

Figure 6 shows the increasing and sawtooth evolution of all curves from 28 days until the end of the trial with a higher mean value (p >0.05) of 0.52±0.040g /d obtained with the treatments fed with imported feed T0+ and lower by 0.33±0.10g/d with the treatment fed with food containing 35% T35 maggot flour.

Specific Growth Rate

Figure 7 illustrates the evolution of the specific growth rate of *Cyprinus carpio* carpillons as a function of the level of incorporation of maggot meal from the housefly *Musca domestica* into the local feed.



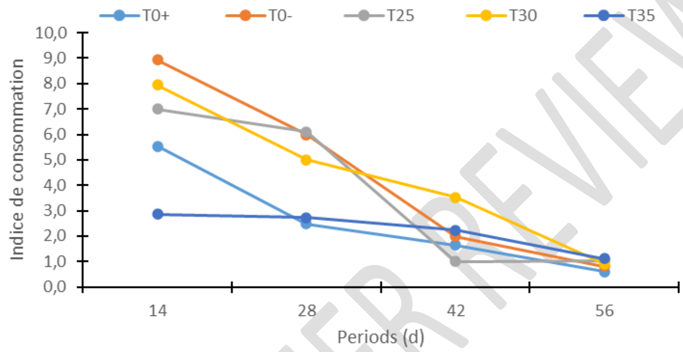
T_{0-} = Feed without maggot flour; T_{25}=Feed containing 25% maggot flour; T_{30}=Feed containing 30% maggot meal; T_{35}=Feed containing 35% of d=day maggot meal

Figure 7: Periodic evolution of the specific growth rate of *Cyprinus carpio* fry fed with local feed formulated with maggot flour.

From 14 to 28 days, decreasing curves are observed and between 42 to 56 days. These curves become increasing with a higher myean value ($p > 0.05$) of 2.93±0.17 obtained with the incorporated feed T_{0+} (coppens) and lower of 2.142±0.16 with the feed containing 30% of maggot flour T_{30}.

Conversion ratio

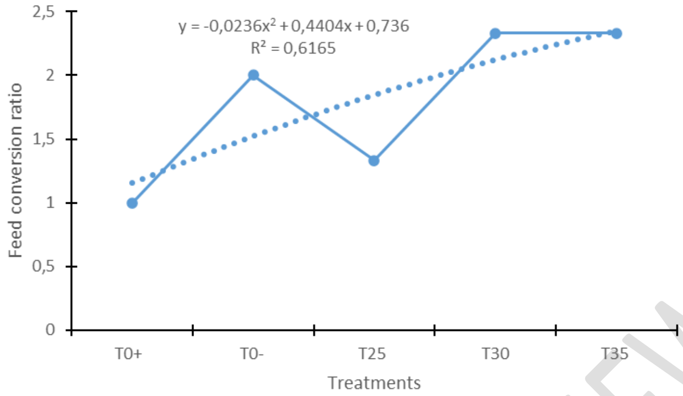
Figure 8 shows the evolution of the consumption index of *Cyprinus carpio* carpillons as a function of the level of incorporation of flour from the larvae of the house fly *Musca domestica*.



T_{0-} = Feed without maggot flour; T_{25}=Feed containing 25% maggot flour; T_{30}=Feed containing 30% maggot meal; T_{35}=Feed containing 35% of d=day maggot meal

Figure 8: Periodic evolution of the consumption index of *Cyprinus carpio* fry fed with local feed formulated with maggot flour

From this reason we observe a regular and decreasing evolution over the entire period of the test with a higher conversion ratio with the T_{30} and T_{35} treatments where the maggot flour was incorporated at 30 and 35%. From Figure 9 we can observe that the incorporation of maggot meal at increasing rates into the diets of *Cyprnus carpio* fry leads to an increase in the conversion ratio.



T_{0-} = Feed without maggot flour; T_{25}=Feed containing 25% maggot flour; T_{30}=Feed containing 30% maggot meal; T_{35}=Feed containing 35% of d=day maggot meal

Figure 9: Regression of the conversion ratio according to the rate of incorporation of maggot flour into the feed of *Cyprnus carpio* fry.

Discussion

The survival rates recorded vary between 14.66±6.11 to 50.66±6.11% depending on the level of incorporation of maggot flour and in comparison with Coppens. These values are lower than 69.85 – 70.15% reported by [9] in *Cyprinus carpio* larvae of 0.001 – 1.9g fed on zooplankton and 71 – 87% obtained by [10] in larvae of 0.001g of *Cyprinus carpio* fed with liver and yeast feed for 36 days. They are also lower than 96.29-100% reported by [11] on juvenile *Cyprinus carpio* weighing 13.68g. The differences in mortality observed here would be due to exogenous factors (physico-chemical characteristics, overnutrition) polluting the living environment (clogging of basins).

Average weights are between: 9.00±1.00 and 6.00±1.00g. These values are lower than 30.60g obtained by [9] in the larvae of *Cyprinus carpio* with an initial average weight of 0.001 – 1.9g fed on zooplankton and 70.38g recorded by [12] in the juveniles of *Cyprinus carpio* of 29, 6–32.4g fed a local feed made from African snail meat. However, these results (9.00±1.00 and 6.00±1.00g) are higher than 1.16-8.34g found by [10] in larvae of the same species *Cyprinus carpio* fed on a local feed at liver and yeast base. This difference in values would be linked to the growth stage of *Cyprinus carpio*, to physicochemical factors as well as to the quality of the formulated feed.

Daily weight gains vary between 0.33±0.10 to 0.52±0.040g/day. These values are lower than 0.61 – 1.20g/d and 1.12-1.20g/d reported by [9] and [13] in *Cyprinus carpio* larvae fed for 45 days with the types of feed. These results are lower than 2.63-3.03 g/d obtained by [13]. Likewise in 10.1 g fry of the same species. The differences in growth observed at the end of the trial between these treatments would come from the species and its size, the feed used, and the rearing conditions.

The specific growth rates obtained are between 2.14±0.16 to 2.93±0.17%g/d. These results (2.14±0.16 to 2.93±0.17%g/d) are higher than 0.56%/d as reported by [9] in larvae weighing 0.001g fed with zooplankton. Nevertheless, these specific growth rates (2.14±0.16 to 2.93±0.17%g/d) corroborate those obtained (2,792.92%g/d) by [11] in fry of 13 .68g fed with a food based on black soldier fly larvae flour. These differences in values could be linked to the species, weight, feed, stocking density, breeding infrastructure.

The conversion ratio vary between 1.00±00 and 2.33±0.57. These values (1.00±00 and 2.33±0.57) corroborate with those reported (1.55-1.7) by [9]. However, these results values (1.00±00 and 2.33±0.57) are significantly lower than those reported (1.44-2.53) by [11], fed with a feed based on corn flour. larvae of the black soldier fly. This slight difference would be linked to the culture medium of the house fly larvae, to endogenous factors (the origin, strain, size, sex and age of the fry used) and exogenous (the quality of the feed and the physicochemical parameters of water).

CONCLUSION

At the end of this study on the effect of the level of incorporation of *Musca domestica* maggot flour on some zootechnical performances of *Cyprinus carpio* fry in unfertilized ponds shows that the feed containing 25% of the flour of the larvae of *Musca domestica* generated the zootechnical performances closest to the control batches over the entire study period.

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