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Weight gain comparison in *Cyprinus carpio* (Linnaeus, 1758) cultured in a biofloc system with four different carbon sources

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Abstract
In Mexico the national production of ornamental fish takes place in 23 states, where 160 species and varieties are cultured for diverse interests, within these species is the koi carp. The experiment took place in the laboratory of Live Food Production of Universidad Autonoma Metropolitana, Unidad Xochimilco. The carps were fed with particulate food of 2mm of diameter with 45% of protein. Four carbon sources were used: coffee, moringa, macroalgae and yucca. The experiment lasted six months. The carps that obtained the highest weight were the ones with Moringa as carbon source with 909.48 ± and the lowest were the ones with coffee with 403.47 ±0.20 g. All final weights showed significant differences ($P<0.001$) in the four experimental systems. The use of vegetable flours (yucca, moringa and macroalgae) as carbon sources for flocs production and their capacity to maintain good water quality in Biofloc system, are a good alternative for ornamental fish culture.

Keywords: biofloc system, *Cyprinus carpio*, weight gain, carbon sources

1. Introduction

Aquaculture worldwide represents a huge genetic diversity richness within and between species. FAO recognize the quick growth of contribution of aquaculture to food security, giving technical support through the implementation of Responsible Fishing Conduct Code, which promotes the sustainable development of aquaculture, especially in developing countries, through a better environmental sector development, health management and biosecurity.

Provides analysis and periodic informs about the state of development of aquaculture also worldwide and regional tendencies, sharing knowledge's and information. Develops and implements politics and legal frameworks efficient that promotes the sustainable and equitable development of aquaculture with better socioeconomic benefits [1].

In Mexico the national production of ornamental fish is a business with high perspectives of social and economic growth that develops in 23 states, where 160 species and varieties are cultured for different purposes, one of them is koi carp. Ornamental fish commercialization in Mexico increased 250% during the last ten years and it produces nearly 4500 million pesos, from 700 productive unities [2]. In the lasts decades, within the aquaculture sector, it has been developed a series of production systems for culture of diverse aquatic organisms, orientated to decrease the use of water and space, increasing considerably the culture density [3]. Mexico has a great fishing and aquaculture potential worldwide, therefore it has the responsibility to ensure the rational and sustainable use of fishing and aquaculture resources, so it have been implemented technologies that guarantee it; one of these technologies is Biofloc system.

Biofloc system is described as aggregates (flocs) of algae, bacteria, protozoa and other type of particulate organic matter, as feces and non-consumed food that causes a deterioration of water quality. Each floc is joined together in a loose matrix of mucus that is secreted by bacteria, united by filamentous microorganisms; is a source of vitamins, minerals and probiotics. From the total of food, a range of 20 to 30% of nitrogen is assimilated by fish, which implies that 70 to 80% of the nitrogen from the food is liberated in the culture medium as waste, which incorporates to bacterial cells that are a main component of Biofloc and consumption of this microbial protein contributes to fish growth [4, 5]. The advantages of Biofloc system has been

proved in many investigations, that mentions the favorable results in growth and survival through the exclusive consumption of microbial protein for 24 hours [6], mainly heterotrophic, which are in charge of depuration of water quality, using nitrogenous compounds potentially toxic for fishes (such as ammonium, nitrites and nitrates) for the synthesis of proteins and microbial biomass, that enrich Biofloc [7]. It is necessary to add carbon sources that stimulate the growth of heterotrophic and maintain constant aeration in the water column, which will help in the combination of physical, chemical and biological factors required for the formation of biotic flocs [8, 9] and therefore an increase of weight of the organisms in culture [10] and avoid the environmental impact of high nutrient discharges. This allows the producer to decrease the use of water in culture system, and application of artificial food [10].
Therefore, the aim of this study is to compare the gain of weight in *Cyprinus carpio* cultured in a Biofloc system, using four different carbon sources to produce bacterial bio mass that allows a better gain of weight in less culture time.

2. Materials and Methods
2.1 Experimental design
The experiment took place in the laboratory of Life Food Production in Universidad Autonoma Metropolitana, Unidad Xochimilco. Four Rotoplas® water tanks with a capacity of 450 L were used and were filled with 300 L of water, previously chlorinated. With continuous and vigorous aeration to help flocs formation. Environmental temperature was maintained at 23°±2°C during all the experiment. In each container 25 juveniles were placed with an average length and weight of 5 cm and 2.10±0.44 respectively. The carps were fed with particulate food of 2mm of diameter with 45% of protein. Four different carbon sources were used: coffee, moringa, macroalgae and yucca. The experiment lasted six months from January to July 2018 (Fig.1).

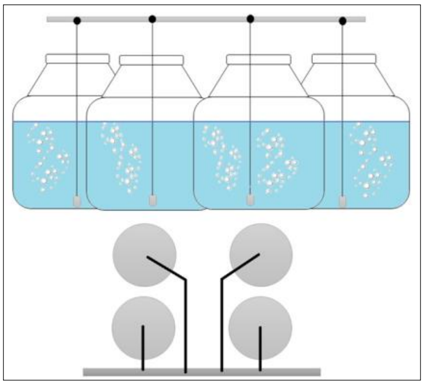

Fig 1: Experimental design

2.2 Supplied food
Carps were fed with the 5% of the total biomass with particulate trout food (45% of protein) with 2mm of diameter. The total of daily food was given in two rations, one in the morning at 9:00 hrs. and the other at 16:00 hrs. Carbon source for each container was supplied at a portion of 0.01% of the Total weight of the organisms. This was supplied once per day at 9:00 hrs. Each 15 days the organisms were weighed with the aim of a digital balance Ohaus with precision of two decimals.

2.3 Weighed of the organisms
Each 15 days, the organisms were extracted from the container and placed in a 10 L container with four drops of clove oil to numb them and be able to weigh them easily. With the obtained total weight, the amount of food and carbon source were adjusted (always maintaining the same proportion 5% of food, 0.01% of carbon source).

2.4 Information processing
Weight values of each organism, per experimental carbon source, were introduced to a data base in Excel 2010 to obtain its descriptive statistic. With the average values per sampling it was obtained a growth tendency curve.
It was also obtained

1 Absolut Growth Rate (AGR)

$$TCA = \frac{Weight_{final} - Weight_{initial}}{\text{Number of days cutivated}}$$

2. Instantaneous Growth Rate (IGR)

$$TCI = \frac{LN(Weight_{final}) - LN(Weight_{initial})}{\text{Number of days cultivated}} \times 100$$

3. Weight gain (WG)

WG = (Final Weight – Initial Weight)

4. Gains in percentage (G %)

$$G\% = \frac{\text{Final Weight} \times 100}{\text{Initial Weight}}$$

2.5 Statistical analysis
A variance analysis (ANDEVA) was made with the final values of the obtained weight by the organisms, through the statistical program SYSTAT 12.0. By finding significant differences ($P<0.05$), it was made a multiple media analysis through Tukey Test, to compare treatments.

3. Results
In Table 1 it is shown the mean values of carp weight in each sampling. The carps that obtained the highest weight were the ones with Moringa as carbon source with 909.48±0.61 g and the ones with lowest weight were the ones with Coffee with 403.47±0.20 g. All final weights of the carps presented significant differences ($P<0.001$) in the four experimental systems. All growth tendency curves were polynomic grade three with an $R^2=1$ (Fig. 2).

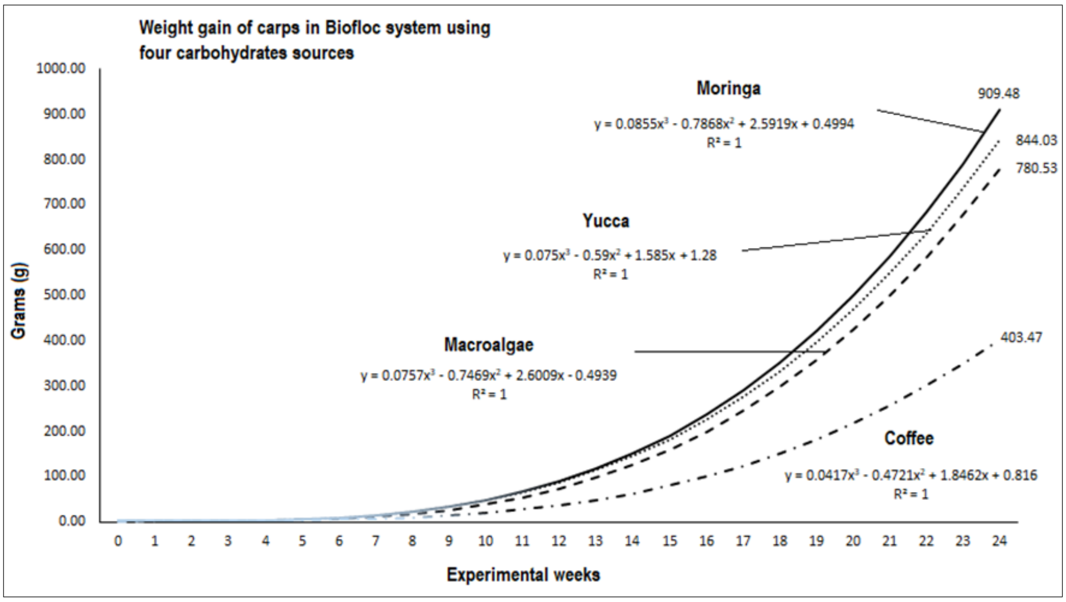

Fig 2: Weight growth tendency curves of *Cyprinus carpio* in a Biofloc system with four different carbon sources.

In Fig. 3, it is presented the values of AGR, IGR, Weight gain in grams and percentage. As it can be observed, the experiment with the carbon source of Coffee presented the lowest values (AGR = 2.39 g day^{-1}; IGR = 3.09% day^{-1}; Gain in grams = 401.21 g and in percentage = 18,078.28%). The highest values were obtained in the experiments with Macroalgae (IGR = 3.75% day^{-1}; weight gain in percentage = 54,361.93%) and Moringa (AGR = 5.40 g day^{-1}; Weight gain = 907 g). The other two experimental carbon sources presented ranges of AGR between 4.64 and 5.01 g day^{-1}; IGR between 3.50 and 3.75 g day^{-1}; Weight gain 779.09 (54361.93%) and 841.68 g (35916.17%).

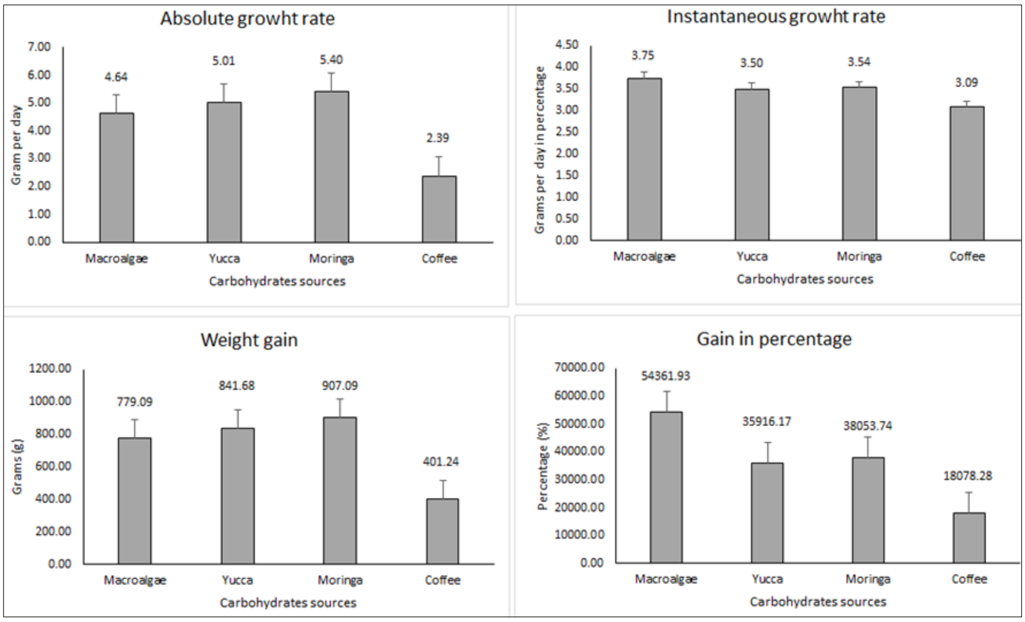

Fig 3: Values of AGR, IGR, and weight gain in grams and percentage of *Cyprinus carpio* in the four experimental carbon sources.

Table 1: Average weight (±S.D.) of *Cyprinus carpio* cultured in a Biofloc system with different carbon sources

Sampling	Macroalgae	Yucca	Moringa	Coffee
0	1.44±0.65	2.35±0.52	2.39±0.82	2.23±0.48
1	2.33±0.68	2.69±0.43	3.22±0.69	2.95±0.54
2	2.63±0.60	2.75±0.63	3.50±0.60	3.23±0.22
3	2.80±0.73	2.98±0.62	3.75±0.82	3.32±0.48
4	3.30±0.67	3.83±0.66	4.48±0.80	3.46±0.68
5	4.57±0.68	5.75±0.48	6.19±0.67	3.90±0.40
6	7.08±0.78	9.19±0.44	9.42±0.74	4.91±0.17
7	11.27±0.60	14.60±0.66	14.66±0.82	6.72±0.30
8	17.60±0.63	22.43±0.60	22.43±0.78	9.59±0.51
9	26.53±0.71	33.13±0.66	33.24±0.64	13.77±0.25
10	38.50±0.81	47.15±0.54	47.61±0.79	19.50±0.33
11	53.97±0.56	64.94±0.60	66.05±0.82	27.05±0.30

12	73.40±0.62	86.95±0.57	89.07±0.85	36.65±0.46
13	97.25±0.58	113.63±0.57	117.19±0.75	48.56±0.39
14	125.95±0.84	145.43±0.51	150.91±0.78	63.02±0.47
15	159.98±0.67	182.80±0.60	190.76±0.78	80.30±0.42
16	199.78±0.69	226.19±0.64	237.24±0.70	100.64±0.62
17	245.81±0.56	276.05±0.58	290.87±0.75	124.28±0.28
18	298.52±0.69	332.83±0.53	352.16±0.59	151.49±0.47
19	358.36±0.81	396.98±0.44	421.62±0.69	182.50±0.25
20	425.80±0.82	468.95±0.45	499.77±0.69	217.57±0.52
21	501.28±0.76	549.19±0.57	587.11±0.69	256.96±0.42
22	585.26±0.65	638.15±0.57	684.17±0.76	300.90±0.18
23	678.19±0.62	736.28±0.66	791.46±0.60	349.66±0.62
24	780.53±0.57	844.03±0.53	909.48±0.61	403.47±0.20

4. Discussion

Biofloc technology has proved to be a successful technic in the prevention of accumulation of nitrogenous toxic metabolites, manipulating the proportion of Carbon/Nitrogen and converting them in organic particles and heterotrophic microorganisms [11, 12, 13]. In a Biofloc system, the microorganism that grow are closely related with the particulate organic matter that is maintained in suspension by continuous aeration. Phytoplankton and bacteria, that are part of this complex of live organisms that are in Biofloc, metabolize the nitrogenous wastes of fish and crustaceans' intensive culture [14].

There are several works of fish culture in Biofloc system. The works of Avnimelech [15], Azim and Little [8], Crab *et al*. [12, 16] and Widanarni y Puspita [17] have shown positive effects in the culture of tilapia; Bakshi *et al*. [18] observed the survival and growth of tilapia hatchlings with molasses and corn starch, as carbon sources obtaining good results; also, in African catfish (*Clarias gariepinus*) [19]; there are many studies of the effect of Biofloc in common carp (*Cyprinus carpio*) like the investigations made by Najdegerami *et al*. [20], using molasses as carbon source; Castro *et al*.[21] used coffee, moringa and molasses as carbon source.

Castro *et al*. [22], made an experiment of the growth of *C. auratus* for 120 days, using a dry diet enriched with *Lactobacillus casei* (Yakult®), where they obtained a gain of weight of 2.520 g. Compared to Castro *et al*. [21] (2016), after 120 days of experimentation, the gain of weight was of 19.80 g. while they obtained 9.9 g and 6 g using molasses, moringa and coffee respectively as carbon source for 60 days. In this experiment, during the same period, moringa presented very similar values, reaching a value of 6.19±0.67. What differs in this work are the carbon sources, because it was used yucca and macroalgae, reaching a weight gain near to 6 g. The diets allowed that the experiment lasted longer, so fish increased their weight gain at 90 days of experimentation and the carbon sources macroalgae, yucca and moringa, reached weight gains of more than 17 g after 90 days, being yucca and moringa the ones who reached values of 22.43 g. The fish with coffee only reached values of 9.59 g. for the same period.

Bakhshi *et al*. [18], mentioned that the application of different carbon sources in a Biofloc systems, can affect the water quality, the formation of flocs and composition of the microbial community coming that affect the growth of carps. In this experiment it was not observed, but the application of these vegetable sources allowed to obtain a good growth in carps, because it was formed an adequate bacterial community for the zooplankton production in the carp culture [23, 24], reaching a weight gain above 750 g. Being moringa the one that presented better results in weight gain (909.48). Ballester *et al*. [25], Crab *et al*. [26], Becerril *et al*. [27], mentioned that microorganisms in Biofloc flocs play an important role in the essential nutrient provision for microalgae, as base source of zooplankton community and nutrients for the growth of bacteria in the Biofloc system, allowing the carps, trough the experiment, to have a extra food source available all the time and to maintain a good water quality during all the experimentation.

5. Conclusions

According to the obtained results the experimental carbon source Moringa allows a better Biofloc production and therefore a better weight gain in carps. Nevertheless, the other carbon sources allow to have a good weight gain, so they can be used in the culture of this fish and its possible implementation in other ornamental species.

6. References

1. FAO. FAO yearbook. Fishery and Aquaculture Statistics. 2014; Rome, Italy. 2016, 105.
2. SAGARPA. Peces de ornato, bellos y recreativos. https://www.gob.mx/sagarpa/articulos/peces-de-ornato-bellos-y-recreativos. Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación. 2016; México.
3. Monroy DM, Lara AR, Castro MJ, Castro MG, Emerenciana CM. Composición y abundancia de comunidades microbianas asociadas al Biofloc en un cultivo de tilapia. Revista de Biología Marina y Oceanografía. 2013; 48(3):511-520.
   Cisneros R. Rendimiento poblacional del rotífero nativo *Brachionus* sp. Cayman, utilizando diferentes enriquecedores. Redalic. 2011; 10:99-105.
4. Hargreaves JA. Photosynthetic suspended-growth systems in aquaculture. Aquacultural Engineering. 2006; 34:344-363.
5. Hargreaves JA. Biofloc Production Systems for Aquaculture. En: SRAC. 4503:8-10.
6. Zapata Lovera KP, Luis Otavio Brito, Priscilla Celes Maciel de Lima, Luis Alejandro Vinatea Arana, Alfredo Olivera Galvez, Jessie Marina Vargas Cárdenas. Cultivo de alevines de tilapia en sistema Biofloc bajo diferentes relaciones carbono/nitrógeno. Boletin do Instituto de Pesca, São Paulo. 2017; 43(3):399-407.
7. Kubitza F. Criação de tilapias em sistema com bioflocos sem renovação de agua. Panorama da Aqüicultura. 2011; 21(125):14-23.
8. Azim ME, Little DC. The Biofloc technology (BFT) in indoor tanks: water quality, Biofloc composition, and growth and welfare of Nile tilapia (*Oreochromis niloticus*). Aquaculture. 2008; 283:29-35.

9. Emerenciano M, Ballester ELC, Cavalli RO, W Wasielesky. Effect of Biofloc technology (BFT) on the early postlarval stage of pink shrimp *Farfantepenaeus paulensis*: growth performance, floc composition and salinity stress tolerance. Aquaculture International. 2011; 19:891-901.
10. Collazos LF, Arias CJ. Fundamentos de la tecnología Biofloc (BFT). Una alternativa para la piscicultura en Colombia. Una revisión. Orinoquia. 2015; 19(1):77-86.
11. De Schryver Crab PR, Defoirdt T, Boon N, Verstraete W. The basics of bio-flocs technology: the added value for aquaculture. Aquaculture. 2008; 277:125-137.
12. Crab R, Kochva M, Verstraete W, Avnimelech Y. Bio-flocs technology application in overwintering of tilapia. Aquaculture Engineering. 2009; 40:105-112.
13. Green BW, KK Schrader, PP Perschbacher. Effect of stocking biomass on solids, Phyto plankton communities, common off-flavors, and production parameters in a channel catfish biofloc technology production system. Aquaculture Research. 2014; 45:1442-1458.
14. Monroy-Dosta M, Rodríguez-Montes de Oca G, Castro Mejia J. and Becerril-Cortés D. Importance and function of microbial communities in aquaculture systems with no water exchange. Scientific Journal of Science. 2015; 4:103-110.
15. Avnimelech Y. Feeding with microbial flocs by tilapia in minimal discharge bioflocs technology ponds. Aquaculture. 2007; 64:140-147.
16. Crab R, Chielens B, Wille M, Bossier P, Verstraete W. The effect of different carbon sources on the nutritional value of bioflocos, a feed for *Macrobrachium rosenbergii* postlarvae. Aquaculture Research. 2010; 41:559-567.
17. Widanarni DW, Puspita F. Aplikasi bakteri probiotik melalui pakan buatan untuk meningkatkan kinerja pertumbuhan udang windu Penaeus monodon. Journal Sains Terapan Edisi. 2012, 2(1).
18. Bakhshi F, Ebrahim H. Najdegerami, Ramin Manaffar, Amir Tukmechi, Kaveh Rahmani Farah. Use of different carbon sources for the biofloc system during the grow-out culture of common carp (*Cyprinus carpio* L.) fingerlings. Aquaculture. 2018; 484:259-267.
19. Ekasari J, Rivandi DR, Firdausi AP, Surawidjaja EH, Zairin M, Bossier P. 2015. Biofloc technology positively affects Nile tilapia (*Oreochromis niloticus*) larvae performance. Aquaculture. 2015; 441:72-77.
20. Najdegerami EH, Bakhshi F, Lakani FB. Effects of biofloc on growth performance, digestive enzyme activities and liver histology of common carp (*Cyprinus carpio* L.) fingerlings in zero-water exchange system Fish Physiology and Bio chemistry. 2016; 42:457. https://doi.org/10.1007/s10695-015-0151-9
21. Castro MG, Castro MJ, De Lara AR, Monroy DMC, Ocampo CJA, Davila FS. Length, weight and condition factor comparison of *Carassius auratus* (Linnaeus, 1758) juveniles cultured in biofloc system. International Journal of Fisheries and Aquatic Studies. 2016; 4(6):345-350.
22. Castro BT, Monroy MCD, Castro JM, De Lara RA, Castro GM. Efecto de cuatro probióticos en el crecimiento y la sobrevivencia de *Carassius auratus*. International Journal of Fisheries and Aquatic Studies. 2011; 19(1):21-28.
23. Wei Y, Shao AL, Wang L. The effect of different carbon sources on the nutritional composition, microbial community and structure of bioflocs. Aquaculture. 2016; 465:88-93.
24. Deng M, Jieyu Chen, Jingwei Gou, Jie Hou, Dapeng Li, Xugang He. The effect of different carbon sources on water quality, microbial community and structure of biofloc systems. Aquaculture. 2018; 482:103-110.
25. Ballester ELC, Abreu PC, Cavalli RO, Emerenciano M, Abreu L, Wasielesky W. Effect of practical diets with different protein levels on the performance of Farfantepenaeus paulensis juveniles nursed in a zero-exchange suspended microbial flocs intensive system. Aquaculture Nutrition. 2010; 16:163-172.
26. Crab R, Defoirdt T, Bossier P, Verstraete W. Biofloc technology in aquaculture: beneficial effects and future challenges. Aquaculture. 2012, 356-357, 351-356.
27. Becerril-Cortés D, María Del Carmen Monroy-Dosta, Mauricio Gustavo Coelho Emerenciano, Germán Castro-Mejía, Beatriz Sofia Schettino Bermúdez and Gilberto Vela Correa. Effect on nutritional composition of produced bioflocs with different carbon sources (Molasses, coffee waste and rice bran) in Biofloc system. International Journal of Fisheries and Aquatic Studies. 2018; 6(2):541-547.