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USE OF RESTAURANT FOOD PROFITS IN NILOTIC TILAPIA FEEDING

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ABSTRACT - Aquaculture is the fastest growing sector in food production, however spending on feed, which can reach up to 80% of the total cost of production. In an attempt to solve this problem, one of the options would be to substitute traditional ingredients for alternatives, in an attempt to minimize the final cost of the feed. Thus, the objective of this work was to evaluate levels of inclusion of restaurant waste in the productive performance, in Nile tilapia, for this purpose 300 juveniles were used. The animals were distributed in 10 boxes of 500 L, being interconnected in a water recirculation system, with an average of two liters of water per minute, using a biological filter for mineralization of ammonia in nitrite, and of nitrite in nitrate and a system continuous aeration with "microporous" stones connected to a portable air compressor. The experimental design used was completely randomized, with four treatments, with performance with five replications and digestibility with three. The treatments consisted of four isoproteic and isoenergetic diets, with different levels of inclusion of the restaurant meal bran (0, 5, 10 and 15%). The physical-chemical parameters of the water, such as dissolved oxygen, pH and temperature were analyzed throughout the experimental period, monitored every two days. The fish were subjected to a 12-hour photoperiod followed by light. At the end of the experimental period, the animals were fasted for 24 hours, then sacrificed by thermal shock with ice and subsequently submitted to biometry. The inclusion of restaurant waste bran at different levels did not negatively affect the performance of the animals, up to 45 days of age.
Keywords: *Oreochromis niloticus*, food waste, fish, protein.

APROVEITAMENTO DE RESÍDUOS ALIMENTARES DE RESTAURANTE NA ALIMENTAÇÃO DE TILÁPIA NILÓTICA

RESUMO - Aquicultura é o setor que mais cresce na produção de alimentos, contudo o gasto com rações, que pode chegar a até 80% do custo total da produção. Na tentativa de solucionar este problema, uma das opções seria a substituição de ingredientes tradicionais por alternativos, na tentativa de minimizar o custo final da ração. Desta forma, o objetivo deste trabalho foi avaliar níveis de inclusão do resíduo de restaurante no desempenho produtivo, em tilápia do Nilo, para isso foram utilizados 300 juvenis. Os animais foram distribuídos em 10 caixas de 500 L, sendo interligadas em sistema de recirculação de água, com vazão média de dois litros de água por minuto, com uso de filtro biológico para mineralização de amônia em nitrito, e de nitrito em nitrato e um sistema de aeração contínua com pedras "microporosas" conectadas a um compressor de ar portátil. O delineamento experimental utilizado foi inteiramente casualizado, com quatro tratamentos, sendo o de desempenho com cinco repetições e de digestibilidade com três. Os tratamentos foram constituídos de quatro rações isoprotéicas e isoenergéticas, com diferentes níveis de inclusão do farelo de resíduo de restaurante (0, 5, 10 e 15%). Os parâmetros físico-químicos da água, como oxigênio dissolvido, pH e temperatura foram analisados durante todo o período experimental, monitorados a cada dois dias. Os peixes foram submetidos a um fotoperíodo de 12 horas seguido de luz. Ao final do período experimental, os animais foram submetidos a jejum de 24 horas, depois sacrificados por choque térmico com gelo e posteriormente submetidos à biometria. Em conclusão a inclusão do farelo de resíduo de restaurante nos diferentes níveis, não afetou o desempenho dos animais, nos 45 dias de experimento.
Palavras-chave: *Oreochromis niloticus*, resíduos alimentares, peixes, proteína.

INTRODUCTION

Organic solid waste when not managed by means of efficient systems has affected the quality of life of communities that the results generated are highly polluting. The amount of waste generated during food processing activities, as well as uneaten remains, is worrying, as they are discarded as waste (GASPAR et al., 2020)

A large amount of waste that produces errors and does not play a role in the society in which it was discarded, however, is disposed of incorrectly. Thus, this enormous potential is already recognized by several countries, whose organic waste management is intrinsically related to the local economy, fostering income, employment and mitigation of environmental impacts (ZAGO and BARROS, 2019). The World Economic Forum has often pointed out that the "circular economy", as a model, makes it possible to reintroduce costs in reducing the reduction of natural resources (LEITÃO, 2015). This new direction for a change in the very concept of packaging, which is now

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considered as resources, since, to a large extent, it can be reused.

In fish farming, there are some obstacles to the success of production, one of them is the expense with feed, which can reach up to 70% of the total cost of production (RODRIGUES et al., 2012).

Within the total of fish farming, the creation of tilapia can be pointed out as a relevant fact to the national scenario since about 45% of the continental culture is of tilapia. The main hubs are concentrated in production in nurseries in western Paraná state, in Brazil, and production in net tanks in reservoirs in the Northeast and Southeast. It should be noted that in the Northeast, tilapia production takes place along the São Francisco River axis and along the Jaguaribe River, in the northeast of Brazil (KUBZITA, 2015). Other factors that contribute to the importance that tilapia currently have in fish farming are their rapid growth at high rates and the organoleptic characteristics present in the meat, with fillets without the presence of intramuscular spines in a "Y" shape (RIGHETTI et al., 2011).

In order to boost fish farming, it is necessary to improve production techniques in the areas of genetic improvement, nutrition, management, health and animal welfare, due to the need to produce more in increasingly smaller spaces with the duration of the cycle. production as little as possible. As a result, numerous problems have arisen, especially with regard to the health and well-being of these animals (BRITO et al., 2019). Therefore, in an attempt to solve the problem of the large production of organic residues and the high cost of feeding the animals, without compromising health, one of the options would be to replace traditional ingredients with alternatives, in an attempt to minimize the final cost of ration.

However, it should be noted that, as a pioneer, the technical-scientific feasibility study is extremely important to subsequently carry out an economic feasibility study. Obviously, the assessment of economic viability in aquaculture is important since the focus of fish farming is to produce high quality products at the lowest possible cost. Several studies on the effects of alternative food cite economic concerns as one of the important factors to be analyzed (HAYGOOD and JHA, 2018). In this context, the objective of this work was to evaluate levels of inclusion of organic food residues in the diet of Nile tilapia.

MATERIAL AND METHODS

The residues were collected at the Restaurants of the Federal University of Espírito Santo (UFES) and the Federal Institute of Espírito Santo (IFES), both with *Campus* in Alegre, located in the southern region of the State of Espírito Santo, Brazil.

The food compost produced by the waste processing was used to compose rations for nilotic tilapia (*Oreochromis niloticus*). After analysis of the residue, the following chemical composition was verified: Dry matter (DM) = 93%, Raw Energy (RE) = 5,600 Kcal kg^{-1}, Crude Protein (CP) = 25%, Ethereal Extract (E.E.) = 21%, Raw Fiber (RF) = 1.6%, Calcium (Ca) = 1%, Phosphor (P) = 1.5% and Mineral Matter (M.M.) = 6.9%. Subsequently, the respective percentages (0, 5, 10 and 15%) of residue were included in the base commercial ration (MS% = 92.5%, EB = 4,492 Kcal kg^{-1}, CP% = 37%, E.E. = 9,6%, FB = 3%, Ca% = 1.2%, P = 0.6% and M.M. = 6.2%) and the new rations were pelleted. The pellets were broken and separated so that the visual presentation was compatible with the diameter of the fish's mouth.

Then, the performance experiment was carried out, in a period of 45 days, where 300 sexually reverted male Nile tilapia juveniles were used. A completely randomized design was used, with 4 treatments (residue inclusion levels) and five replications. The animals were distributed in 10 boxes of 500 L, being interconnected in a water recirculation system, with an average flow of 2 L min^{-1} of water, with the use of a biological filter for the mineralization of ammonia in nitrite, and of nitrite in nitrate, and a continuous aeration system using "micro-porous" stones connected to a portable air compressor. Feeding was performed five times a day: between 9:00 am and 5:00 pm, at 2 h intervals, until apparent satiation, in a proportion that allows maximum intake with minimum feed loss.

The physical-chemical parameters of the water, such as dissolved oxygen, pH and temperature were analyzed throughout the experimental period, monitored every 2 days. The fish were submitted to a photoperiod of 12 h followed by light. At the end of the experimental period, the animals were fasted for 24 h, then sacrificed by thermal shock with ice and subsequently submitted to biometry.

For statistical analysis, ANOVA was performed, and in case of statistical difference, regression analysis and Tukey's test at 5% probability were performed, both using the SISVAR program (FERREIRA, 2011).

RESULTS AND DISCUSSION

The results presented in Table 1 indicate that there was no significant difference ($P>0.05$) between the levels of inclusion of restaurant food waste on most of the variables studied in relation to the productive performance of Nile Tilapias and the water quality of the aquariums. There was no significant difference ($P>0.05$) for any of the variables analyzed in Table 1. These data are consistent with those reported by Ramos et al. (2001) who, working with fingerlings of Tambaqui (*Colossoma macropomum*), evaluated two diets (one with 18% crude protein from fish silage and one with 22% crude protein from fishmeal) and observed that fish fed with fish silage and fish meal at the end of the experiment showed similar weight and feed conversion, without significant differences.

However, feed intake was affected, as there was a difference ($P<0.05$) between the treatments used, showing that the inclusion of the residue affects the use of feed (Table 2), precisely because the residue is richer in energy than the base ration, which led the animals' fed diets with greater inclusion of residue to reduce the consumption of the ration, precisely because they managed to reach their energy demand with less amount of ration.

The results of the present study also corroborate those verified by Oliveira et al. (2006) who evaluated the

performance of Nile tilapia fingerlings (*Oreochromis niloticus*) receiving increasing levels (0, 10, 20, 30, 40 %) of acid silage in replacement of fish meal in the diet and found that there was no significant difference (P> 0.05) for final weight gain, total feed intake, conversion and height increase.

TABLE 1 - Final weight (FW), total length (TL), standard length (SL), height (H), weight gain (GP), feed conversion (FC), total length gain (TLG), length gain (LG) and height gain (HG), as a function of the inclusion of restaurant food residue levels (0, 5, 10 and 15%) in the diet of Nile Tilapia fingerlings.

Variables	Restaurant food residue levels (%)				CV(%)
	0	5	10	15	
FW (g)	32.80a*	33.10a	31.80a	31.50a	14.87
TL (cm)	12.00a	12.20a	12.00a	12.00a	24.34
SL (cm)	9.94a	9.92a	9.89a	12.30a	28.32
H (cm)	3.22a	3.13a	3.24a	7.07a	13.12
FC (g/day)	19.50a	19.90a	19.80a	18.80a	11.21
TLG (cm/day)	2.60a	2.66a	2.66a	2.54a	12.64
LG (cm/day)	2.44a	2.42a	2.58a	4.82a	18.12
HG (cm/day)	0.55a	0.47a	0.66a	4.44a	17.19

*Means followed by the same lowercase letter in the lines do not differ from each other by Tukey's test (P>0.05).

TABLE 2 - Feed intake (FI), feed conversion (FC), specific growth rate (SGR), specific development rate (SDR), protein efficiency rate (PER), pH of the water in the boxes, dissolved oxygen in the water (O_2) and average water temperature in the boxes (T), as a function of the inclusion of restaurant food residue levels (0, 5, 10 and 15%) in the diet of Nile Tilapia fingerlings.

Variables	Restaurant food residue levels (%)				CV(%)
	0	5	10	15	
FI (g/day)	25.63ab*	26.11a	24.25ab	23.91 b	14.19
FC (g g^{-1})	1.33a	1.32a	1.23a	1.29a	21.31
SGR (%)	2.01a	2.04a	2.17a	2.01a	12.83
SDR (%)	0.54a	0.55a	0.56a	0.53a	25.40
PER (%)	2.11a	2.13a	2.27a	2.19a	25.87
pH	7.48a	7.42a	7.44a	7.52a	10.71
O_2 (mg L^{-1})	6.16a	6.32a	6.20a	6.38a	23.17
T (ºC)	24.38a	24.36a	24.40a	24.34a	5.67

*Means followed by the same lowercase letter in the lines do not differ from each other by Tukey's test (P>0.05).

It was observed that the feed consumption (Table 2 and Figure 1), in the present study, was affected (P< 0.05) of the levels of inclusion of food residues from the restaurant. Thus, the increase in feed consumption caused by the increase in the inclusion of restaurant food waste (up to 10%) may be, according to Takishita et al. (2009), an indication that better balances of amino acids in the diet stimulate the feed intake of fingerlings.

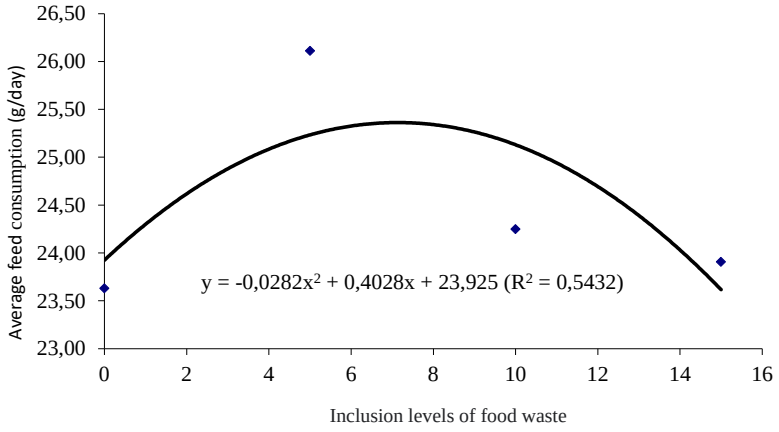

FIGURE 1 - Scatter plot of feed intake as a function of the inclusion of different levels of restaurant food residue (0, 5, 10 and 15%) in the diet of Nile Tilapia fingerlings.

Unbalanced amino acid profiles in the diet can lead to a decrease in feed intake and negatively affect animal performance (CARNAÇÃO et al., 2006). Brito et al. (2019), studying the performance of Nile tilapia juveniles fed with probiotic strains and submitted to a sanitary challenge, found that there was no significant effect (P>0.05) on the parameters of zootechnical performance, feed intake and survival and the use of probiotics in the diet was not able to provide improvements in performance, feed consumption and survival of Nile tilapia juveniles in the period of 30 days of culture.

Espe et al. (1999), in studies carried out with rats using diets supplemented with fish residue in the proportion of 6 to 8%, did not find any influence on consumption. However, as reported by Honczaryk and Maeda (1998), one of the mechanisms involved in inducing the consumption of a diet is the chemical stimulus originated by substances that are soluble in water, probably this may have occurred during the feeding of the animals due to the residue present high value of ether extract (21.00%).

As for the parameters of water quality, temperature is one of the parameters of fundamental importance in cultures of aquatic organisms, as it can influence the increase or decrease of fish metabolism (MARQUES et al., 2004).

Lima et al. (2019) evaluating the effect of supplementation with *Chlorella vulgaris*, a green microalgae, and molasses application rates on water quality, zootechnical performance, proximate composition and health of Nile tilapia fingerlings (*Oreochromis niloticus*) cultured in biofloc systems with low salinity (10 g L^{-1}), verified that the system affected the zootechnical performance, feed consumption, sedimentation time and hematological indexes of the fingerlings, impairing their development. Thus, they showed that inadequate food supplementation, associated with unfavorable environmental conditions, leads to negative performances on the part of the animals.

The water temperature of all cultures remained similar (p>0.05) due to controlled conditions in the laboratory, not suffering external influences. As well as temperature, salinity, pH and OD were also maintained at acceptable levels (KUBITZA, 2000) and without statistical difference between treatments (P>0.05) throughout the experimental period (Table 2). These results are very important, especially regarding dissolved oxygen (O_2), considered one of the most critical variables, as it considerably affects the survival and resistance of fish. Dissolved oxygen concentrations lower than 4.0 mg L^{-1} can change the aquatic environment and lead to a reduction in the food consumption of animals and, consequently, a decrease in the growth rate (SARAIVA et al., 2009).

The pH in the units remained within the ideal range, according to Zhou et al. (2009), for the production of freshwater fish, which is 6.5 to 9.0. Outside this comfort zone, fish development is compromised and, depending on the case, can cause a high mortality rate. The temperature of the water in the tanks (24.37°C) remained below the ideal range for a good performance of tropical fish, which is 28 to 30°C, according to Kesarcodi-Watson et al. (2008), however for this species, which according to Lima et al. (1988) is 25-32°C.

CONCLUSION

The inclusion of restaurant waste bran at different levels did not negatively affect the performance of the animals, up to 45 days of age.

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