EVALUATION OF THE ADDITION OF GARLIC POWDER IN NILE TILAPIA RATION (*Oreochromis niloticus*)

Avaliação da adição de alho em pó na alimentação de Tilápia do Nilo (Oreochromis niloticus)

Evaluación de la adición de ajo en polvo a la dieta de tilapia del Nilo

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ABSTRACT

Evaluated the effect of levels of garlic powder (0.0, 1.0, 2.0 and 3.0 g.kg^{-1}) added to diets for Nile tilapia on animal performance, villi height and diet digestibility. The rations consisted of pellets and tilapia and were fed to apparent satiation for 60 days. 120 fish, with initial average weight of 4.20 ± 0.4 g, were masculinized and distributed in 24 aquariums of 70L in a randomized design consisting of four treatments and six replications in a closed circulation system with constant aeration. 240 fishes was used for feces collected by an indirect method (Guelph modified system) and estimation of coefficients of apparent digestibility using 0.5 g.kg^{-1} of chromic oxide as an inert indicator incorporated into the ration. No significant differences in performance related to organ weight, the hepato-somatic index, the viscero-somatic fat index and villi height were observed. However, the apparent digestibility coefficient of rations was negatively affected by the addition of garlic powder. Garlic powder as an additive in rations for Nile tilapia did not provide positive effects as a growth promoter and worsened the digestibility of nutrients among the tested treatments.

Keywords: additive, aquaculture, digestibility, performance.

RESUMO

Estudou-se o efeito de níveis de alho em pó (0.0, 1.0, 2.0 e 3.0 g.kg^{-1}) como aditivo em rações para tilápia do Nilo sobre o desempenho, vilosidades intestinais e digestibilidade. As rações foram peletizadas e ofertadas até a aparente saciedade aos animais durante 60 dias. 120 peixes com peso médio inicial de 4,20 ± 0,4 g, masculinizados, foram distribuídos em 24 aquários de 70L num delineamento inteiramente casualizado, com quatro tratamentos e seis repetições, em um sistema de recirculação de água e aeração constante. 240 peixes foram utilizados para coleta de excretas e determinação dos coeficientes de digestibilidade pelo método indireto (sistema modificado de Guelph), e foram usadas 0,5 g.kg^{-1} de Cr_2O_3 como indicador inerte incorporado as rações. Não foram observadas diferenças significativas para o desempenho e em relação as variáveis de: peso dos órgãos (PO), índice hepato-somático (IHS), índice de gordura vicero-somática (IGVS) e altura de vilus. Entretanto, os coeficientes de digestibilidade aparente das rações foram afetados negativamente com a adição de alho em pó. O

alho em pó como aditivo na ração para tilápia do Nilo não apresenta efeitos positivos sobre como promotor de crescimento e piorou a digestibilidade de nutrientes nos níveis estudados.
Palavras-chave: *aditivo, aquicultura, desempenho, digestibilidade.*

RESUMEN

Estudió el efecto de los niveles de ajo en polvo (0.0, 1.0, 2.0 y 3.0 g.kg^{-1}) como aditivo en las dietas de tilapia del Nilo en el rendimiento, las vellosidades intestinales y la digestibilidad. Las raciones se granularon y se ofrecieron hasta saciedad aparente a los animales durante 60 días. Ciento veinte peces machos con un peso inicial medio de 4.20 ± 0.4 g se distribuyeron en 24 acuarios de 70L en un diseño completamente al azar con cuatro tratamientos y seis repeticiones en un sistema de recirculación de agua y aireación constante. Se utilizaron 240 peces para la recolección de excretas y la determinación de los coeficientes de digestibilidad por el método indirecto (sistema modificado del Guelph), y se usaron 0,5 g.kg^{-1} de Cr_2O_3 como indicador inerte incorporado en las dietas. No se observaron diferencias significativas en el rendimiento y con respecto a las variables de: peso del órgano (PO), índice hepato-somático (IHS), índice de grasa viromatomática (IGVS) y altura de las vellosidades. Sin embargo, los coeficientes de digestibilidad aparentes de las dietas se vieron afectados negativamente por la adición de ajo en polvo. El ajo en polvo como aditivo alimenticio para la tilapia del Nilo no tiene efectos positivos sobre el promotor del crecimiento y empeora la digestibilidad de los nutrientes en los niveles estudiados.
Descriptores*: aditivo, acuicultura, performance, digestibilidad.*

INTRODUCTION

Aquaculture in Brazil, especially in the Northeastern region, has received attention for favourable environmental conditions of availability of water and appropriate weather for expansion and growth, in particular for Nile tilapia (*Oreochromis niloticus*) aquacultures.

However, with increasing cultivation density, diseases are becoming more problematic, leading to the increased use of antibiotics (LIU *et al*., 2017). These fish are commonly exposed to stressful situations such the transfer from the natural environment to captivity or between different fish cultures and the high densities of cultivation and intensive management of animals, leading to a depression of defense mechanisms, thereby rendering them more susceptible to infectious diseases and directly affecting the growth of these animals (SANTOS *et al*., 2013).

Consequently, for the proper development of tilapia cultures, especially in intensive fish-breeding systems with high stocking density, it is necessary to utilize food rations that provide fast growth but still maintain good nutritional status of the animals. As a result, the use of antibiotics has been used in rations for preventing the proliferation of opportunistic pathogens and consequently promoting a higher growth of animals. However, the use of chemotherapeutics has been linked to human cross-resistance to bacteria and other microorganisms (SHAKYA and LABH, 2014).

One alternative to chemotherapeutics is the use of plant extracts, of which garlic is already widely known for its medicinal properties. Thus, garlic powder (*Allium sativum*) has been tested as a growth promoter in slaughter chickens (KAMRUZZAMAN and KHANDAKER, 2016), pigs (YAN and KIM, 2013; LOVATTO *et al*., 2005) and in fishes (ROSNY *et al*., 2016; SHALABY *et al*., 2006).

As an alternative to the use of chemotherapy, garlic, among other plant extracts, appears to be a natural alternative to antibiotics, being is less costly and harmless to humans. The purpose of the current study was to evaluate the effect of levels of garlic powder added to diets for Nile tilapia on animal performance, villi height and diet digestibility.

MATERIAL AND METHODS

The experiment was conducted at the Aquatic Animals Laboratory of Evaluation (LAQUA), Department of Fishery and Aquaculture of the Federal Rural University of Pernambuco, over a period of 60 days. Was utilized a total of 120 (fingerlings) Nile tilapia individuals masculinized with an initial average weight of 4.20 ± 0.4 g, distributed in 24 tanks of 70 L in a randomized design using four treatments and six replications in a closed recirculation water system with constant aeration and biofiltering, for experiment of performance. The rations were formulated according to the nutritional requirements for tilapias (FURUYA, 2010). The diet was based on soybean, corn and fish-meal with varying levels of garlic powder (0.0, 1.0, 2.0 and 3.0 $g.kg^{-1}$) according to the treatment. Kaolin was used as an inert material to be replaced by adding garlic powder within the various treatments (Table 1).

Table 1. Percentage Composition of the experimental diets

Ingredients	Garlic powder ($g.kg^{-1}$)			
	0.0	1.0	2.0	3.0
Soy meal	53.97	53.97	53.97	53.97
Corn	29.35	29.35	29.35	29.35
Fish meal	8.91	8.91	8.91	8.91
Garlic powder	0.0	1.0	2.0	3.0
Soy oil	2.92	2.92	2.92	2.92
Dicalcium phosphate	0.68	0.68	0.68	0.68
Limestone	0.81	0.81	0.81	0.81
Salt (NaCl)	0.35	0.35	0.35	0.35
DL-metionine	0.08	0.08	0.08	0.08
Suplement (vit and min)[1]	0.50	0.50	0.50	0.50
Inert (kaolim)	3.0	2.0	1.0	0.0
Nutrients calculate				
DE – Digestible energy ($kcal.kg^{-1}$)[2]	3.144	3.144	3.144	3.144
DM – Dry matter ($g.kg^{-1}$)[3]	96.06	96.20	95.58	95.98
CP- Crude protein ($g.kg^{-1}$)[4]	32.5	32.5	32.5	32.5
CP- Crude protein ($g.kg^{-1}$)[3]	33.35	33.55	33.57	33.61
CF – Crude fiber ($g.kg^{-1}$)[4]	3.83	3.83	3.83	3.83
Fat ($g.kg^{-1}$)[4]	4.70	4.70	4.70	4.70
Starch ($g.kg^{-1}$)[4]	25.58	25.58	25.58	25.58
Methionine +cystine ($g.kg^{-1}$)[4]	1.08	1.08	1.08	1.08
Total methionine ($g.kg^{-1}$)[4]	0.62	0.62	0.62	0.62
Lysine ($g.kg^{-1}$)[4]	1.91	1.91	1.91	1.91
Thryptophan ($g.kg^{-1}$)[4]	0.41	0.41	0.41	0.41
Valine ($g.kg^{-1}$)[4]	1.71	1.71	1.71	1.71
Threonine ($g.kg^{-1}$)[4]	1.27	1.27	1.27	1.27
Arginine ($g.kg^{-1}$)[4]	2.41	2.41	2.41	2.41
Leucine ($g.kg^{-1}$)[4]	2.57	2.57	2.57	2.57
Phenilalanine ($g.kg^{-1}$)[4]	1.55	1.55	1.55	1.55
Hystidine ($g.kg^{-1}$)[4]	0.84	0.84	0.84	0.84
Isoleucyne ($g.kg^{-1}$)[4]	1.54	1.54	1.54	1.54
Calcium ($g.kg^{-1}$)[4]	1.20	1.20	1.20	1.20
Available phosphorus ($g.kg^{-1}$)[4]	0.59	0.59	0.59	0.59

[1]Guarantee levels for kilogram of the product: vit. A = 900.000 UI; vit. D3 = 50.000 UI; vit. E = 6.000 mg; vit. K3 = 1200 mg; vit. B1 = 2400 mg; vit. B2 = 2400 mg; vit. B6 = 2000 mg; vit.B12 = 4800 mg; folic acid = 1200 mg; calcium pantothenate = 12.000 mg; vit. C = 24.000 mg; biotina = 6.0 mg; choline = 65.000 mg; niacin= 24.000

mg; Fe = 10.000 mg; Cu = 600 mg; Mn = 4000 mg; Zn = 6000 mg; I = 20 mg; Co = 2.0 mg e Se = 25mg). [2]*According Pezzato et al. (2000).* [3]*Analyzed in Laboratory of Animal Nutrition/Dept. Animal Science/UFRPE.* [4]*According Rostagno et al. (2011).*

Ingredients for the rations were pre-dried in an oven using forced air at 55ºC for 48 h. Raw garlic was obtained from an open market-place on the streets of Recife, Pernambuco, Brazil without specific variety was used, crushed and then dehydrated to obtain garlic powder. Subsequently, the ingredients were ground using a Willey mill in a 2-mm sieve and homogenized. Following this, the mixture was pelletized in a meat grinder, dried in an oven of forced ventilation (55ºC) over a period of 48 h, then, crushed and sorted according to the size of the animals. The rations were offered three times a day (8 am, 12 pm and 5 pm) by manual feeding until the apparent satiation of the animal

Rations were analyzed for chemical composition considering: dry matter (DM), crude fibre (CF), crude protein (CP), fat, ash and levels of chromic oxide (Cr_2O_3).

The digestibility trial was conducted at the Laboratory of Digestibility of non-Ruminants, Department of Animal Science, Rural Federal University of Pernambuco. To evaluate the apparent digestibility coefficients (ADC) of DM, CP and gross energy (GE) of Nile tilapia rations with levels of added garlic powder according to the treatments (0.0, 1.0, 2.0 and 3.0 $g.kg^{-1}$) (Table 1), increased with 0.5 $g.kg^{-1}$ of Cr_2O_3 as an inert marker.

A total of 240 Nile tilapia, masculinized, were distributed in 12 modified tanks (Guelph modified system) containing 80 L of water to collect faeces. Before the experimental period, the fish were acclimatized to laboratory conditions for 15 days.

During the day, the fish were kept in aquariums (three cages per tank of 500 L), where they received meals without restraint from 7 am to 4 pm and most frequently during the afternoon. Subsequently, they were transferred to the faecal collection tanks (one cage per tank) made of fibreglass and a capacity of 300 L, which had a cone shape bottom with a valve attached to a 200 mL bottle of clear vinyl (for faeces collection). The fish were kept in these tanks until the morning of the next day (8 am) where they were returned to the nourishment aquaria to start a new cycle. This procedure allowed the collection of faeces with no direct or indirect food contamination. The ADC of rations, GE and CP were determined according to the formula described by Nose (1960).

At the end of the evaluation of performance, the fish were kept without food for 24 h, the fishes were sacrificed by spinosectomy after anesthesia with 0.05% of tricaine methanesulfonate (MS222, Sigma) according to the procedures approved by the Animal Ethics Committee of Alagoas Federal University (nº 07/2018). For which the bodies were subjected to biometry where a longitudinal cut was made in the ventral region to remove and weigh the liver, viscera and visceral fat.

The evaluated characteristics were average weight gain (WG), average feed intake (FI), feed conversion rate (FCR), protein efficiency ratio (gain weight / protein consumed) (PER) and final weight (FW). In addition, the hepato-somatic index [(liver weight/body weight) × 100], visceral-somatic fat index [(fat weight removed in the ventral region/body weight) × 100] and organ weights were assessed.

The water temperature, dissolved oxygen (DO), pH, total ammonia nitrogen and nitrate nitrogen were monitored daily with a multi-variable water quality instrument (YSI Professional Plus, YSI Incorporated, Yellow Springs, OH, USA) in situ at 10 am.

The morphometry of the intestinal mucosa was assessed at the end of the experiment of performance at the Histotechnical Laboratory of the Department of Pharmacy, at the Federal University of Pernambuco. To facilitate this, portions of approximately 5-cm length of the initial portion of the intestine (5 cm below the stomach junction with the intestine) of five fish per treatment were collected at the end of the experiment. The samples were opened longitudinally, rinsed with saline solution, fixed in a solution of Bouin solution for 6 h, dehydrated in an ascending series of alcohol, cleared in xylene and embedded in paraffin to obtain histological semi-serial cuts, as described by Silva *et al.* (2010).

Sections of 7-µm thickness were made by the haematoxylin-eosin method. The photo documentation (image capturing) was achieved using a Olympus® BX50 light microscope with a 4X objective lens, using a computerized imaging system (Image Pro Plus Version 5.2, Media Cybernetics®). The morphometry of the intestinal mucosa was assessed to measure the height of the villi where 16 villi per animal and a total of 80 measurements per treatment were performed.

We used a randomized design with four treatments and six replicates, and all data (performance, digestibility and intestinal mucosa morphology) were subjected to analysis of variance and regression ($P < 0.05$) using the Computer Program System for Statistical and Genetics Analysis SAEG®-UFV.

This study was approved by the Ethics Committee for Animal Use (CEUA/UFAL nº 07/2018).

RESULTS AND DISCUSSION

The average values of temperature, pH, nitrite, toxic ammonia and DO during the experimental period were: 27 ± 0.5 °C, 6.8 ± 0.3, 0.15 ± 0.05, 0.25 ± 0.25 and 6.50 ± 0.25 mg. L^{-1}, respectively. The evaluated variables remained stable throughout the experiment and were within the recommended range for the species. The survival was 100% at all levels tested.

There were no statistical differences in the performance results, organ weights, viscero-somatic fat index and hepato-somatic index among fish subjected to the different treatments (Table 2 and 3).

This result was perhaps due to the favorable conditions within the culture that did not allow for the expression of sanitary challenges that could create conditions for observing significant beneficial effects of the use of garlic as a growth promoter.

Corroborating these results, Ndong and Fall (2007) in addition did not find any effects on the performance of hybrid juvenile tilapia *(O. niloticus* vs. *O. aureus*) fed for 4 weeks with levels up to 1 $g.kg^{-1}$ of garlic within their diet.

Table 2. Average values performance of Nile tilapia fed diets with garlic powder in fed diets

Items	Garlic powder ($g.kg^{-1}$)				VC (%)[1]	Test F	Regression
	0.0	1.0	2.0	3.0			
WI (g)	4.21	4.20	4.21	4.20	0.66	ns	Y= 4.20
FW(g)	24.46	24.88	25.36	23.72	13.77	ns	Y=24.60
WG(g)	20.25	20.68	21.15	19.52	16.24	ns	Y=20.40
FI(g)	28.00	28.54	27.76	26.99	10.73	ns	Y=27.82

FCR	1.43	1.39	1.34	1.38	14.34	ns	Y=1.38
PER	1.35	1.39	1.42	1.31	16.61	ns	Y=1.37

**ns = not significative, (P<0,05), [1]VC= Variation coefficient. WI = initial weinght, FW = final weight, WG = average weight gain, FI = average feed intake, FCR = feed conversion rate and PER = protein efficiency ratio.*

Table 3. Average values for intestinal morphometric of Nile tilapia, according for levels garlic powder in fed diets

Items	Garlic powder ($g.kg^{-1}$)						
	0.0	1.0	2.0	3.0	VC (%)[1]	Test F	Regressior
Organs weight (g)	2.333	2.362	2.532	2.286	29.97	ns	Y= 2.378
Viscero-somatic fat index (%)	0.035	0.030	0.031	0.035	27.12	ns	Y= 0.033
Hepato-somatic index (%)	0.717	0.631	0.617	0.659	11.31	ns	Y= 0.656

**ns = not significative. (P<0.05). [1]VC= Variation coefficient*

However, Diab *et al*. (2008) studied the effects of garlic using treatments of 1.0 $g.kg^{-1}$ and 3.0 $g.kg^{-1}$ in rations of Nile tilapia and observed that during the summer, the animals that were fed garlic as a growth promoter did not express a better performance compared with the control group. However, the same study was conducted during the winter when there was a great fluctuation of water temperature and greater effectiveness provided by the deliberate infection by *Pseudomonas fluorescens*, causing stress in animals. The winter results showed that the performance and survival of fish fed with rations containing garlic were higher. Therefore, to achieve better efficiency of prebiotics, certain conditions are necessary to advance their action.

Shalaby *et al*. (2006) identified a linear increment of rising performance in Nile tilapia fed with garlic powder, where the treatment with 3.0 $g.kg^{-1}$ garlic showed the best result, recommending also garlic as a growth promoter for the prevention of opportunistic diseases and to enhance the tolerance for stress produced by intense management and environment changes. Corroborating these results, Metwally (2009) reported that the inclusion of 250 $mg.kg^{-1}$ of garlic powder into the rations of Nile tilapia allowed the best performance results to be obtained.

Although garlic is used in combating and preventing a variety of diseases in fishes with satisfactory results, mainly in Asia (MANOPPO *et al.*, 2016), its effect on performance remains controversial and further studies on the mode of action of garlic powder on growing fishes in different kinds of cultivation conditions are required.

In this present experiment, statistically significant differences between the results obtained in organ weights, viscero-somatic fat index and hepato-somatic index of animals fed with garlic powder were not observed.

This result could be expected because the changes that may occur in the values of HSI and VSFI are usually associated with the accumulation of an energy reserve or problems in lipid or protein metabolism, which may cause liver hypertrophy and a greater accumulation of fat in the inferior ventral region. However, the accumulation of fat in fishes is now becoming more evident during the final growth phase of the animals. However, the animals used in the current experiment, which were in the early stage of growth, showed a low-fat deposition. Santos *et al.*

(2009) also reported this when they worked with Nile tilapia fingerlings.

Corroborating the results of the current experiment, Elias and Ghany (2008) found no significant differences in liver weight of *Clarias gariepinus* fed with rations containing garlic and infected by *Fusarium moniliform.*

Yaoling *et al.* (1998) reported that the effects of *Allium sativum* in nourishment are well known on lipid metabolism and that weighted consumption may decrease the accumulation of fat in the liver, increase the excretion of bile acids in feces and increase the antioxidant capacity, as observed with hamsters. Suggesting a decrease of liver hypertrophy and an improvement in energy metabolism within animals. In the current study, a linear decrease was observed in the digestibility of DM, CP, GE, DE and DP of rations with garlic powder for Nile tilapia (Table 4).

Table 4. Apparent Digestibility Coefficient of fed diets with garlic powder for Nile tilapia.

	Garlic powder ($g.kg^{-1}$)						
Items	0.0	1.0	2.0	3.0	VC%[1]	R^2	Regression
ADC (%) dry matter	79.54	76.28	78.01	72.46	2.84	0.88	Y=79.90-2.177x
ADC (%) Crude protein	90.88	89.14	88.34	87.30	1.37	0.97	Y=90.65-1.15x
ADC (%) Crude Energy	84.04	81.81	81.60	75.98	2.25	0.84	Y=84.51-2.44x
Digestible energy ($kcal.kg^{-1}$)	3115.12	3105.38	3091.13	2821.14	2.57	0.67	Y=3257.2-89.62x
Digestible protein ($g.kg^{-1}$)	29.52	28.82	28.13	28.05	1.37	0.92	Y=29.90-0.51x

[1]*VC= variation coefficient.*

However, Sharma *et al*. (2010) reported that ingestion of small amounts of raw garlic can cause injury to mice liver, and similarly, Hoshino *et al.* (2001) found that human ingestion of raw garlic could cause gastrointestinal disturbances and directly influence the digestibility and utilization of nutrients.

The reduction in digestibility of rations containing garlic fed to animals observed in the current study not supported in the literature. One possible explanation to consider for the results of the current study is that the properties of the garlic may depress the voluntary intake of rations and consequently decrease the digestibility of the nutrients in the rations (LOVATTO *et al.*, 2005).

The morphometric analysis of villus revealed the absence of a trophic effect of garlic powder supplementation ($P < 0.05$, VC = 22.30) for villi height and observed values of 286.52, 292.88, 279.00, 15.00 and 318.29 μm with 0, 1, 2 and 3 $g.kg^{-1}$ of garlic powder in the fed diet (Figure 1), respectively.

Garlic contains allicin, synthesised by the enzyme alliinase from alina (SHAKYA and LABH, 2014) with disruption of cells in the medulla (PRASAD *et al*., 1996). Allicin has been recognized for it's bactericidal, fungicidal and antioxidant properties for at least 5,000 years by Babylonians, Egyptians, Phoenicians, Vikings, Chinese, Greeks, Romans and Hindus (SANTOS *et al*., 2013).

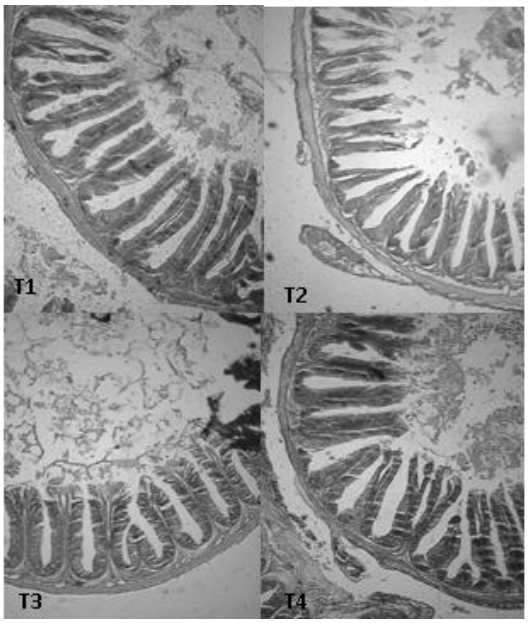

Figure 1. Photomicrography (40x) of villus of Nile tilapia fed diets with levels garlic powder (average values of villus height: T1=286.52, T2=292.88, T3=279.15 and T4 =318.29 μm).

Exhibits a broad antibiotic action against gram-positive and -negative bacteria without contributing to increased bacterial resistance, and in combination with antibiotics, results in a synergistic action against partial or total bacteria (SIVAM, 2001).

Although there is no consensus on the effective action of these natural substances. Some hypotheses have suggested the control of pathogens by their antimicrobial (SANTOS *et al*., 2013) and antioxidant activity, improved digestion by stimulating the enzymatic activity and nitrogen absorption and other effects related to changes in the histology intestinal epithelium, morphology of organs and the control of ammonia production (OETTING *et al*., 2006).

Even though the antimicrobial effects of various plant extracts have been demonstrated in in vitro experiments (REVERTER *et al*., 2014), mechanisms underlying the action remain poorly understood.

The development of the intestinal mucosa consists of increasing villus height and density, which corresponds to an increase in epithelial cells (enterocyte, caliciform and enteroendocrine cells). This occurs because of cell renewal (proliferation and differentiation) by mitosis or by cell loss (extrusion) that occurs in the crypts (MAIORKA *et al*., 2000), or in the case of fishes, at the villi base (SMITH, 2008).

Consequently, a great deal of variation can be observed in the integrity and size of villi among the treatments. In addition, the presence of intestinal crypts in the current experiment was not observed and no significant differences in villous heights of the animals fed with varying levels of ration with garlic powder were observed.

The lack of response in height and width of villi, which could indicate functional changes in absorptive capacity, supports observations of non-significant changes in performance and can also be justified by the relatively ideal environmental conditions in the current experiment that presented no stress to the experimental animals, as previously reported.

Overall, the results of performance and anatomical-morphological characteristics of Nile tilapia fingerlings were not affected by varying levels of garlic powder used during the experiment, which may be due to the bactericidal activity of garlic on the water since the recirculation system used in this experiment could have affected the beneficial action of microorganisms in the biofilter. However, there was a depressive effect on the digestibility of rations by increasing the levels of garlic powder in the rations.

According to O'gara *et al*. (2000), there are additional reports of gastric irritation in some human patients resulting from the administration of garlic in

oral form, and therefore, allicin should be used with particular caution in patients with lesions of the gastric mucosa or inflammations. Thus, the excessive use of extract or garlic capsules can cause gastric irritation, sometimes with fever, intestinal colic, cystitis and vomiting (COSTA *et al*., 2009).

Thus, further studies are required to determine the effects of garlic powder in rations for Nile tilapia under varying stress levels and experimental conditions.

CONCLUSION

The garlic powder used as an additive in rations for Nile tilapia did not provide positive effects as a growth promoter and inhibited the digestibility of nutrients among the tested treatments. Not recommended at the levels tested.

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