Edson Silva
(Organizador)

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Serviços e cuidados

NAS CIÊNCIAS DA SAÚDE 2

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APRESENTAÇÃO

A coletânea *'Serviços e cuidados nas ciências da saúde'* é uma obra composta por 50 capítulos, organizados em dois volumes. O volume 1 foi constituído por 26 capítulos e o volume 2, por 24.

O foco da coletânea é a discussão científica por intermédio de trabalhos multiprofissionais desenvolvidos por autores brasileiros e estrangeiros.

Temas atuais foram investigados pelos autores e compartilhados com a proposta de fortalecer o conhecimento de estudantes, de profissionais e de todos aqueles que, de alguma forma, estão envolvidos na estrutura do cuidado mediado pelas ciências da saúde. Além disso, conhecer as inovações e as estratégias desses atores é essencial para a formação e a atualização profissional em saúde.

Dedico essa obra aos estudantes, professores, profissionais e às instituições envolvidas com os estudos relatados ao longo dos capítulos. Gratidão aos autores que tornaram essa coletânea uma realidade ao partilhar suas vivências.

A você...desejo uma ótima leitura!

Edson da Silva

SUMÁRIO

CAPÍTULO 23

USING PERIPHYTON TO MONITOR MICROBIOLOGICAL CONTAMINATION OF AQUATIC ENVIRONMENTS

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ABSTRACT: Periphyton developed on artificial substrates (polyethylene terephthalate (PET), polyvinyl chloride (PVC) and glass) has been used in fish farming as an alternative to improve the water quality of cultivation systems due to their ability to cycle nutrients from the aquatic environment. However, the periphytic biofilm composition has not been investigated in detail; thus, the objective of this study was to perform microbiological biomonitoring of fish farming through the periphytic community developed on artificial PET substrates. PET strips were installed at sampling points and removed after 30 days to collect the periphyton. Water samples were also collected for microbiological analyses (*E. coli*, *Aeromonas* spp., *Pseudomonas* spp., and *Salmonella* spp.), and the chemical and physical data of the water from each collection point were obtained. *Escherichia coli* was isolated from all water and periphyton samples. In two collections, *Salmonella* spp. and *Aeromonas* spp. were isolated only from the periphyton sample. The fish farming environment is dynamic, with water entering and leaving the tanks; thus, water collection for microbiological biomonitoring may only represent its quality on the collection day and not the general cultivation conditions. In contrast, the formation of periphyton on PET strips allows biomonitoring of the environment over a 30-day period. The use of periphyton for the continuous biomonitoring of tanks should thus be considered a general practice for fish farming management, as it allows identification of possible pathogens in the aquatic environment and facilitates adequate management to prevent disease spread, thus avoiding mortality and consequent financial losses.

KEYWORDS: Periphyton, Fish farming, Biomonitoring, Pathogenic bacteria.

USANDO O PERIFÍTON PARA MONITORAR A CONTAMINAÇÃO MICROBIOLÓGICA DE AMBIENTES AQUÁTICOS

RESUMO: O perifíton desenvolvido em

substratos artificiais (polietileno tereftalato (PET), policloreto de vinila (PVC) e vidro) tem sido utilizado na piscicultura como alternativa para melhorar a qualidade da água dos sistemas de cultivo devido à sua capacidade de ciclar nutrientes do ambiente aquático. No entanto, a composição do biofilme perifítico não foi investigada em detalhes; assim, o objetivo deste estudo foi realizar o biomonitoramento microbiológico da piscicultura através da comunidade perifítica desenvolvida em substratos artificiais de PET. Tiras de PET foram instaladas nos pontos de amostragem e retiradas após 30 dias para a coleta do perifíton. Amostras de água também foram coletadas para as análises microbiológicas (*E. coli*, *Aeromonas* spp., *Pseudomonas* spp. e *Salmonella* spp.), e foram obtidos os dados químicos e físicos da água de cada ponto de coleta. *Escherichia coli* foi isolada em todas as amostras de água e do perifíton. Em duas coletas, *Salmonella* spp. e *Aeromonas* spp. foram isolados apenas da amostra de perifíton. O ambiente da piscicultura é dinâmico, com entrada e saída de água dos tanques; assim, a coleta de água para biomonitoramento microbiológico pode representar apenas sua qualidade no dia da coleta e não as condições gerais de cultivo. Em contraste, a formação de perifíton em tiras de PET permite o biomonitoramento do ambiente por um período de 30 dias. A utilização do perifíton para o biomonitoramento contínuo dos tanques deve, portanto, ser considerada uma prática geral para o manejo da piscicultura, pois permite a identificação de possíveis patógenos no ambiente aquático e facilita o manejo adequado para evitar a disseminação de doenças, evitando assim mortalidade e consequentes perdas financeiras.
PALAVRAS-CHAVE: Perifíton, Piscicultura, Biomonitoramento, Bactérias patogênicas.

1 | INTRODUCTION

Periphyton refers to the viscous material adhering to natural substrates (stones, branches, and plants) in the layers of water bodies (Haddadchi et al., 2020). It is a complex community of micro and meso-organisms, comprising microalgae, protozoa, fungi, bacteria, zooplankton, phytoplankton, animals, inorganic debris, and organic matter that unite in complex microbial consortia (Silva et al., 2016b; Martini, et al., 2019; Tammam, et al., 2020).

Considering its richness in bioproducts such as lipids, carbohydrates, proteins, pigments, and antioxidants (Martini et al., 2019; Tammam, et al., 2020), periphyton developed on artificial substrates such as bamboo, glass, acrylic, polyvinyl chloride (PVC), and polyethylene terephthalate (PET) have been used as alternatives to increase the availability of biomass present in the environment and serve as acomplement to fish feeding (Alves et al., 2020; Sahu et al., 2021; Shahar and Guttman, 2021).

Periphyton developed on artificial substrates in aquatic environments creates an assemblage capable of directly influencing microorganisms, increasing the selection, adaptation, and growth of specific bacterial communities in aquatic microbiota (Silva et al., 2016b). These bacterial group benefit aquaculture systems with numerous functions such as nutrient cycling and reducing the amount of toxic nitrogen compounds (Kataki et al., 2021). These factors thus favor the fixation of biofilm bacteria in this community.

Microorganisms that can compromise fish health can also benefit from this ecosystem

(Silva et al., 2016a); however, the presence of pathogenic microorganisms in the aquatic environment can result in the disease development thus affecting production, resulting in high mortality, and, consequently, economic losses in fish farming (Silva et al., 2016b).

Aeromonas spp. is one of the pathogenic microorganisms that compromise the cultivation system and fish health, as it causes a lethal disease called motile Aeromonas septicemia (MAS) (Pessoa et al., 2020; Zhang et al., 2020). *Pseudomonas* sp. is part of the aquatic ecosystem, but is considered a contaminant or invader because it infects a wide variety of debilitated aquatic species, and is associated with a disease called fin rot, which corrodes the affected area and causes high mortality in fish (Gasparotto et al., 2020). In many species, contamination with *Pseudomonas* spp. causes loss of appetite, hemorrhagic lesions in the skin and at the base of the fins, petechial hemorrhages in the gills and liver, and accumulation of ascetic fluid in the peritoneal cavity, which causes hemorrhagic septicemia and subsequent death (Fernandes et al., 2020).

In recent years, *Salmonella* spp. have been isolated in fish farms, with studies reporting the adherence of *Salmonella* to fish carcasses, and the problems that this contamination can cause to humans (diarrhea, typhoid fever) (Santos et al., 2019; Samanta and Bandyopadhyay, 2020). Thus, monitoring the microbiological quality of fish farms is essential for proper handling to prevent the spread of fish diseases and avoid economic losses.

The microbiological quality of the cultivation system can be used to as a tool used to monitor contamination of the aquatic environment, and most published studies have reported the use of water sampling for this purpose (Silva et al., 2016b, Santos et al., 2019, Zhang et al., 2020). However, this sample only represents the water quality on the day of collection, what is not suitable for fish farming, since fish farming water remains in constant movement, from tank inflow to the cultivation system outflow.

Currently, no reported method allows verification of water quality in a tank over a specified period. Therefore, periphyton developed on artificial substrates is necessary for microbiological biomonitoring, as the time for which the substrate will be submerged in the aquatic environment can be controlled, thus allowing evaluation of contamination in the environment within a specified period (static effect). Therefore, the objective of this study was to evaluate the efficiency of periphyton developed on an artificial substrate (PET) as a tool for microbiological biomonitoring in fish farming.

2 | MATERIALS AND METHODS

2.1 Study sites

This study was conducted in two fish farms located in the Brilhante River watershed belonging to the Grande Dourados region, both in Mato Grosso do Sul, Brazil (Fig. 1). Table 1 shows the fish farming cultivation system.

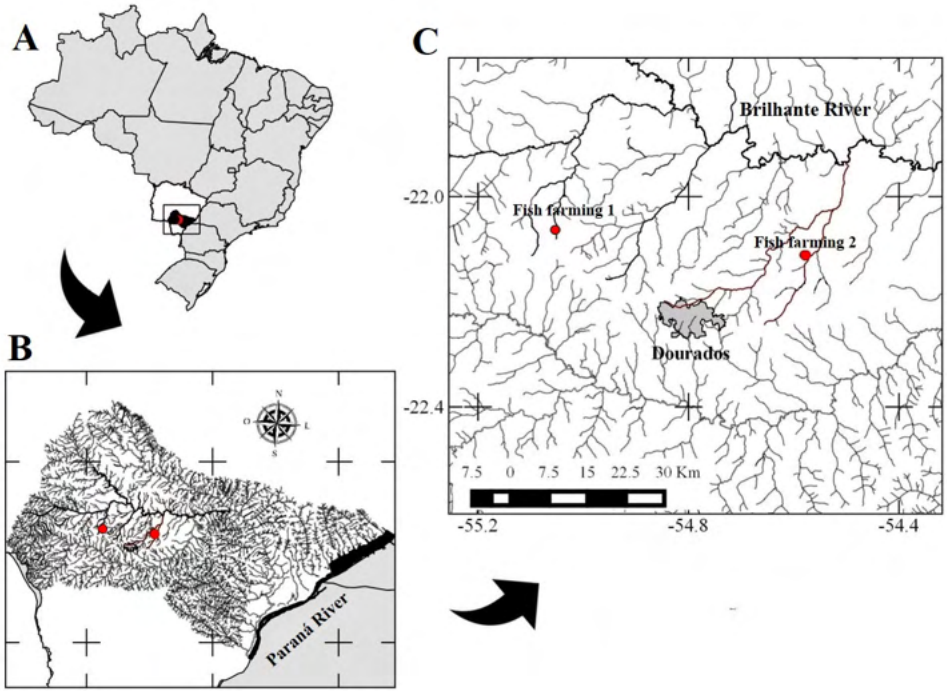

Fig. 1. Fish farm site in the hydrographic microbasin of Brilhante River.

A: Map of Brazil showing the state of Mato Grosso do Sul and the Ivinhema River watershed, **B** – Ivinhema River hydrographic basin highlighting the Brilhante River microbasin, **C** – Fish farms location in the microbasin of Brilhante River.

Author: FERREIRA, F. S., 2021.

Collection sites	Characteristics of the fish farms						
	Cultivation type	**Cultivated species**	**Food**	**Canvas protection at bottom of tanks**	**Aeration**	**Use of fertilization in the tanks before the beginning of cultivation**	**Objective**
Fish farm 1	Fattening	Astyanax (*Astyanax lacustris*)	Commercial feed	No	No	No	Commercial
Fish farm 2	Fattening	Tambaqui (*Colossoma macropomum*), Pacu (*Piaractus mesopotamicus*), Dourado (*Salminus brasiliensis*) and Patinga - Pacu (*Piaractus mesopotamicus*) crossing with Pirapitinga (*Piaractus brachipomus*)	Commercial feed	No	No	No	Subsistence

Table 1 Description of fish farming cultivation practices used in this study.

Three collections were carried out in each fish farm, being the months of June, August and October in Fish Farm 1, and July, September and November in Fish Farm 2. Chemical and physical data as well as water and periphyton samples were collected at the following points:

- Point 1 (P1) – located at the spring that distributes water to fish farming, i.e., water inflow.
- Point 2 (P2) – located in the cultivation tank inside the fish farming area.
- Point 3 (P3) – located in the channel that discharges effluents from fish farming to the stream, i.e., water outflow.

2.2 Water collection

Water samples for microbiological analyses were collected in sterile 500 mL glass bottles, submerged at a 20 cm depth, and were transported in a refrigerated box, complying with the requirement of a maximum of 8 hours between water collection and the beginning of microbiological examination (APHA, 2005).

2.3 Collection, storage, and extraction of periphyton

PET strips (5 cm × 20 cm) were used as artificial substrates for growing the periphytic community, as they provided low-cost and easily handled chemically inert supports. Five strips were installed at each collection point, at a 20 cm depth, 30 days before each collection a period considered favorable for the formation of a mature periphytic community (Fig. 2) (Fernandes, et al., 2020; Sahu et al., 2020; Tammam, et al., 2020).

Fig. 2: Prepared PET strips before and after 30 days submerged at the fish farming collection points.

Source: Rocha, M. P., 2017.

The collected periphyton strips were stored in labelled sterile plastic bags and transported under refrigeration to the Laboratory of Microbiological Assays (LMA) at the Federal University of Grande Dourados.

The periphyton adhered to the PET strips was scraped and collected using stainless steel blades into 200 mL of sterile distilled water. The procedure was performed in a laminar flow chamber; the samples were placed in sealed sterile glass bottles and vortexed for homogenization.

2.4 Physical and chemical analyses

The physical and chemical conditions of water were measured using the YSI Professional Plus multiparameter probe as follows: DO (% and mg/L), dissolved oxygen in percentage and in milligrams per liter; ORP (mV), oxidation reduction potential; pH, potential of hydrogen; Temp (°C), temperature in degrees Celsius; SPC (μS/cm), specific conductance in microSiemens per centimeter; TSD (mg/L), total solids dissolved in milligrams per liter.

2.5 Microbiological analyses

2.5.1 Total coliforms and Escherichia coli

Total coliforms and *E. coli* were determined by the presence and absence of chromogenic and fluorogenic substrates of Colilert® (IDEXX Laboratories, Inc. 2012). In total, 100 mL of water and periphyton samples were stored in analysis bottles, the substrate was added, and the samples were then incubated at 35 ± 0.5°C for 24 ± 2 hours. According to the Colilert® interpretation criteria, the yellow color of the medium indicated the presence of total coliforms, and fluorescence under 360 nm ultraviolet light indicated the presence of *E. coli*.

For *E. coli* isolation, 1 mL of the Colilert "positive" analysis reagent was added to 9 mL of EC broth (HIMEDIA) and incubated at 42 ± 0.5°C for 24 ± 2 hours. After this period, the sample was striated in duplicate by depletion on EMB agar (HIMEDIA). According to the manufacturer's recommendations, colonies that presented a metallic green color were considered as E. coli because these are selective and specific media.

2.5.2 Aeromonas spp. and Pseudomonas spp. analysis

For sample enrichment, 1 mL of the collected water and periphyton sample was added to 9 mL of buffered peptone water (HIMEDIA) and incubated at 30°C for 24 h. Next, aliquots of the cultures were seeded in duplicate in *Aeromonas* medium base (ryan) (OXOID). The strips were then placed in an incubator at 32°C for 24 h (APHA, 2005; Silva, et al., 2017). Colonies that were dark green, opaque with darker centers, and 0.5-1.5 mm in diameter, were identified as *Aeromonas* spp., and colonies with translucent blue/gray color, a point diameter up to 0.25 mm, were identified as *Pseudomonas* spp., according to the

manufacturer's specifications.

2.5.3 Salmonella spp. analysis

Water and periphyton sample pre-enrichment was performed in buffered peptone water (HIMEDIA), followed by selective enrichment in selenite cystine broth (SCB) (ISOFAR) and Rappaport Vassiliadis Broth (RVB) (ISOFAR). Hektoen enteric agar (ISOFAR) was used to isolate microorganisms (APHA, 2005; SILVA et al., 2017). Colonies that presented a transparent halo and central black spots were selected and sorted using Triple Sugar Iron Agar (TSI) and Motility Indole Ornithine (MIO) biochemical methods, and urea was used to confirm the species (APHA, 2005; Silva, et al., 2017).

3 | RESULTS

3.1 Physical and chemical data

According to the Brazilian Resolution n° 357 of 2005 by the National Council of the Environment (*Conselho Nacional do Meio Ambiente* – CONAMA), water intended for aquaculture and fish farming activities is classified as Class 2 water. Table 2 shows the physical and chemical conditions of the fish farming water in this study and the standards established by the legislation.

Some measured values for DO were below the values recommended by the legislation, especially in the third collection from fish farm 1.

Locations/ collections	Points	Measured elements					
		DO (% and mg/L)	ORP (mV)	pH	Temp (°C)	SPC (US/ cm)	TSD (mg/L)
Fish farm 1	1	73.65 / 6.66	-28.63	6.92	20.2	45.0	29.25
1st collect	2	73.4 / 6.46	-7.35	6.55	21.7	126.0	81.9
	3	73.8 / 6.5	-4.2	6.71	21.6	126.0	81.9
2nd collect	1	37.25 / 3.32	-35.7	6.92	21.0	44.0	28.6
	2	85.45 / 7.39	-33.0	7.47	22.6	80.0	52.0
	3	52.0 / 4.54	-27.4	7.53	22.1	79.0	51.52
3rd collect	1	19.05 / 1.72	-11.9	7.05	20.2	43.0	27.95
	2	42.7 / 3.75	-11.5	7.11	21.7	60.0	39.0
	3	32.75 / 2.89	-7.8	7.22	21.3	64.0	41.6
Fish farm 2	1	78.15 / 6.83	-9.4	6.41	22.0	61.0	39.8
1st collect	2	90.0 / 7.74	-45.95	6.54	22.8	55.0	35.75
	3	80.4 / 6.88	-17.7	6.12	23.1	57.0	37.05

2nd collect	1	48.0 / 4.16	-17.85	8.23	22.5	64.0	41.6
	2	83.3 / 6.96	-41.0	8.56	24.4	54.0	35.1
	3	59.5 / 4.97	-25.35	8.34	24.4	51.0	33.15
3rd collect	1	63.55 / 5.42	-18.1	6.66	23.3	63.0	40.95
	2	71.95 / 5.94	-25.1	6.66	25.0	58.0	37.7
	3	67.65 / 5.60	-18.05	6.72	24.9	52.0	33.8
CONAMA 357/2005		Not less than 5.0 mg/L	*	6.0 to 9.0	*	*	Maximum value 500 mg/L

Note: DO (% and mg/L): dissolved oxygen in percentage and milligrams per liter, ORP (mV): oxidation reduction potential in millivolts, pH: potential of hydrogen, Temp (°C): temperature in degrees Celsius, SPC (μS/cm): specific conductance in microSiemens per centimeter, TSD (mg/L): total solids dissolved in milligrams per liter. All relative standard deviations were less than 5% of the mean value of the parameter.

(*) not specified by CONAMA Resolution n° 357 of 2005.

Table 2 Water physical and chemical data of sampling points at the fish farms

The ORP values were negative in all the collections, indicating the presence of dissolved electrons in the water. Therefore, both fish farms had reducing conditions.

The lowest temperature values were observed at point 1, located at the springs in both fish farms. The points that showed the highest values for SPC also showed the highest values for TSD.

3.2 Microbiological analysis

Isolation of bacteria adhered to the periphytic community has not been reported in literature; therefore, standardized techniques were been used to develop the laboratory analyses. We still emphasize that the techniques used in microbiological analyzes identify the presence and absence of the microorganism in the collected sample, and does not quantify the concentration of microorganism in the sample. Table 3 shows the results of water and periphyton microbiological analyses.

E. coli was isolated from all the collections and points studied, both in water and periphyton samples. This bacterium is often used as an indicator of fecal contamination in aquatic environment studies.

The periphyton sample contained more isolated *Aeromonas* spp. In the first collection of fish farm 2, *Aeromonas* were found only in the periphyton sample.

Pseudomonas was absent in both samples (water and periphyton) only in the first collection of fish farm 2, at point 3 (exit).

In *Salmonella* analysis, most isolates were obtained from periphyton samples. Further, in the first collection from fish farm 1, *Salmonella* was isolated only in the periphyton sample, and was absent in the water sample.

4 | DISCUSSION

Continuous monitoring of the physical and chemical parameters of the fish farm (DO, ORP, pH, temperature, SPC, and TSD) allows fish farmers to control changes in the environment and avoid production losses. Fore et al. (2018) reported the importance of knowing the physical and chemical data of the local environment, as many of these factors affect fish growth, development, and well-being, and monitoring these conditions during production can facilitate decision making in fish management.

Locations/ collections	Points	Microorganisms isolated from water				Locations/ collections	Points	Microorganisms isolated from periphyton			
		E. coli	*Aeromonas* spp.	*Pseudomonas* spp.	*Salmonella* spp.			*E. coli*	*Aeromonas* spp.	*Pseudomonas* spp.	*Salmonella* spp.
Fish farm 1 1st collect	1	x	x	x	-	Fish farm 1 1st collect	1	x	x	x	x
	2	x	x	x	-		2	x	x	x	x
	3	x	x	x	-		3	x	-	x	x
2nd collect	1	x	-	x	-	2nd collect	1	x	x	x	x
	2	x	x	x	x		2	x	x	x	x
	3	x	x	x	x		3	x	x	x	x
3rd collect	1	x	x	x	x	3rd collect	1	x	x	x	-
	2	x	x	x	x		2	x	x	x	-
	3	x	x	x	x		3	x	x	x	x
Fish farm 2 1st collect	1	x	-	x	x	Fish farm 2 1st collect	1	x	x	x	x
	2	x	-	x	-		2	x	-	x	-
	3	x	-	-	x		3	x	x	-	x
2nd collect	1	x	x	x	x	2nd collect	1	x	x	x	-
	2	x	-	x	-		2	x	-	x	x
	3	x	x	x	x		3	x	x	x	x
3rd collect	1	x	x	x	-	3rd collect	1	x	x	x	x
	2	x	x	x	x		2	x	x	x	x
	3	x	x	x	-		3	x	x	x	x

Note: (x) presence, (-) absence of the microorganism.

Table 3 Microorganisms isolated from water and the periphytic community in the fish farm.

The measured values of SPC and TSD in this study were within the limits allowed by the Brazilian legislation. SPC is measured by the concentration of dissolved salts and

other inorganic materials in water; thus, if the total dissolved solids increase (total weight of mineral components present in water per unit volume), the TSD increases. The levels of organic residues in fish farms are related to animal excrement and unconsumed food. These residues may cause damage to the environment due to the high sedimentation load of total dissolved solids and the presence of nutrients such as nitrogen and phosphorus (Cacho et al., 2020).

ORP measures indicate the reduction and oxidation activities in water. This method is used to test the decomposition process of organic materials because ORP measures the potential of electricity contained in the environment and can indicate whether the decomposition process of organic matter in water occurs in a state of reduction (negative) or oxidation (positive) (Hariyadi et al., 2020). Fish farms in this study presented reduced environments because all ORP values were negative.

This study highlights the efficiency of using periphyton for the microbiological biomonitoring of aquatic environments. As periphyton is commonly used for fish feeding supplementation and for water treatment in tanks, it can easily provide fish farmers with a third advantage, for biomonitoring the environment.

The use of periphyton sampling in the microbiological biomonitoring of fish farms proved to be effective, as we could isolate all groups of bacteria studied in all samples obtained from both fish farms. Godinho-Orlandi and Barbieri (1983) reported that during periphyton formation, microorganisms are the first colonizing organisms, with colonization times varying from a few hours to a few days.

Our determined period of 30 days for periphyton colonization was effective as adherence of the periphytic community was observed on the PET strips in all collected samples. According to existing literature, the periphytic community reaches a climax, or a phase with a mature community, over a period of 28 to 30 days (Fernandes, et al., 2020; Sahu et al., 2020; Tammam, et al., 2020).

Silva et al. (2016a) studied the microbial composition in the periphyton developed on artificial substrates (PVC) installed in fish farming tanks with Nile tilapia (*Oreochromis niloticus*), but they did not identify the genera of the isolated microorganisms performed only the total count. In the present study, microorganisms of both economic and sanitary interest in fish farming were isolated directly from the periphyton and were identified.

E. coli are commonly found in aquatic environments (Rocha et al., 2018; Ibrahim et al., 2019; Mathai et al., 2019). Here, breeding of animals like horses and cattle, which drink water from a source near the fish farm, may have contributed to the isolation of *E. coli* from the sources (collection point 1) of both fish farms studied.

Aeromonas spp. were isolated from the water and periphyton in both fish farms. According to Leira et al. (2017) and Kim et al. (2018), *Aeromonas* spp. are the main causes of fish disease, with clinical signs ranging from superficial to deep skin lesions that can progress to ulcers and typical septicemia. The fish farms in this study were supplied by

springs and the water flowed from one tank to the next, in a rustic system, allowing cross contamination, because there was no control on the quality of the water flowing into these fish farms. The presence of *Pseudomonas* in the water and in the periphyton in all collections from both fish farms is a worrying fact, as infection of fish by *Pseudomonas* spp. can cause mortality and consequently, significant economic losses to the fish farmer (Carvalho et al., 2015).

Salmonella spp. were isolated in ten water samples and in 14 periphyton samples, indicating that periphyton is better for evaluating the presence of this microorganism. The source of *Salmonella* contamination in fish farms has been little explored, except when studies are focused on fish meat, relating its contamination to the quality of water and the living environment (Costa et al., 2016). However, *Salmonella* spp. are the main microorganisms linked to food-borne diseases and are associated with the production chain of birds and pigs, but are increasingly present in the fish production chain.

As expected, the results obtained in our microbiological analyses did not show any distinction by the collection points, as point 1 was located in the spring and point 3 was in the effluent of the fish farm. The management practices used in fish farming may interfere with the health of the environment, because all groups of microorganisms found in this study can be pathogenic to fish. Early diagnosis and accurate treatment of bacterial infections in fish farming are key to success, as they can prevent the spread of fish diseases.

Further, the use of periphytic biofilms for microbiological biomonitoring of aquatic environments indicates the actual contamination in the environment over a certain period (static effect). In contrast, water in the fish farms is subject to movement (dynamic effect), which does not allow determination of the actual contamination present in the aquatic environment over a period, but only allows evaluation of contamination on the day of collection.

The data obtained in some collections, where isolates of the studied microorganism were obtained only in the periphytic biofilm, are justified by the premise that most microorganisms in natural environments are fixed to substrates and are not dispersed particles in suspension (Costerton et al., 1978), and that microorganisms are grouped together in biofilms to protect planktonic cells and for survival in hostile environments (Donlan and Costerton, 2002).

5 I CONCLUSION

Microorganisms were isolated from the periphytic community adhered to the artificial PET substrate in all groups of pathogenic bacteria (*E. coli*, *Aeromonas* spp., *Pseudomonas* spp., *and Salmonella* spp.). The periphyton proved an efficient tool for the microbiological biomonitoring of fish farms, microorganism isolation indicated that the bacterium was present in the cultivation system during the estimated time of 30 days. Thus, microbiological

evaluation of the periphyton can be used as a suitable management tool for fish farming, because identification of pathogenic bacterial groups in the environment can facilitate their proper management and prevent the spread of fish diseases. As management of environmental conditions can support fish health, the presented approach can prevent fish death and consequent financial losses. The results exposed in this study will serve as a basis to guide future research focused at the microbiological biomonitoring of fish farms and aquatic environments, and will complement the data published in the literature on the composition of the bacterial community adhered to the piriphytic biofilm.

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