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Effect of UV-C radiation on quality indicators of striped catfish (*Pangasianodon hypophthalmus*) fillets stored under refrigeration

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ABSTRACT

The striped catfish (*Pangasianodon hypophthalmus*), exported mainly by Vietnam, has been widely accepted by global consumers due to its white meat and low cost. However, the highly perishable nature of fish requires the use of alternative technologies to ensure quality and safety for prolonged storage periods under refrigeration. This study investigated the effect of UV-C radiation (1.95 mW/cm^2 for 90 s) on biochemical quality parameters of striped catfish fillets stored at 4 °C for 9 days. Refrigerated samples were analyzed for biogenic amines, pH, total volatile basic nitrogen (TVB-N), ammonia, and lipid oxidation. UV-C-treated fillets had lower ($P < 0.05$) levels of TVB-N, ammonia, and biogenic amines, and higher ($P < 0.05$) lipid oxidation than untreated fillets during the storage period. UV-C-treated fillets had higher ($P < 0.05$) pH levels than untreated fillets until day 5 of storage, although both had similar pH levels ($P > 0.05$) on days 7 and 9. This technology is a possible alternative for conservation of striped catfish fillets, but other doses of UV-C must be evaluated to mitigate or prevent the negative effect on lipid oxidation observed here.

KEYWORDS: UV-C method; emerging technology; quality parameters; HPLC-DAD.

INTRODUCTION

Striped catfish (*Pangasianodon hypophthalmus*) is a farmed freshwater species, exported mainly by Vietnam, which has been widely accepted by global consumers due to its nutritional value, white meat, and low cost, leading to international market expansion (FAO, 2016; WASENITZ; KARL; PALM, 2018). In recent decades in Brazil, striped catfish has been marketed as frozen fillets.

It is well known that the composition of fish favors bacterial growth (GHALY *et al.*, 2010) and oxidative processes (MONTEIRO *et al.*, 2017), which are correlated with loss of quality and the production of several toxic compounds, such as biogenic amines, ammonia, and malondialdehyde from lipid oxidation (THRANE *et al.*, 2013; ZAKI *et al.*, 2014; ZARE *et al.*, 2015). Due to the highly perishable nature of fish and increasing global diffusion of fish and fish products for human consumption, the United Nations Food and Agriculture Organization has encouraged the use of alternative technologies to ensure the quality and safety of these foods (DAMBROSIO *et al.*, 2016; TOPPE *et al.*, 2012).

As the conventional preservation methods for fish (freezing, salting, drying, and canning) increase shelf life but can lead to undesirable changes in quality, technologies that have antimicrobial effects while maintaining physicochemical quality are becoming more widely used. Ultraviolet (UV) light is an emerging non-thermal technology approved for use in foods by the USA Food and Drug Administration (FDA, 2007).

UV light has wavelengths between 100 and 400 nm and is divided into UV-A (315–400 nm), responsible for tanning; UV-B (280–315 nm), which can cause skin burns and possibly skin cancer; and UV-C (200–280 nm), which has a germicidal effect due to its capacity to inactivate bacteria and viruses (KOUTCHMA; FORNEY; MORARU, 2009). UV-C light can damage microorganisms through two different mechanisms. UV-C directly affects microbial DNA; and as an indirect effect, the radiolysis of water by UV-C forms free radicals (OH·; .H_2O_2, H+; among others) (BYELASHOV; SOFOS, 2009; HÄDER; SINHA, 2005). UV-C technology has several advantages including low cost, ease of implementation, absence of toxic residues, and lack of adverse effects when appropriate doses are used (KOUTCHMA; FORNEY; MORARU, 2009; STEWART-MALONE *et al.*, 2015).

Successful application of UV-C radiation for improving the bacterial quality and extending the shelf life of farmed freshwater fish stored under refrigeration has been reported (BOTTINO *et al.*, 2017; LALY *et al.*, 2019; MOLINA *et al.*, 2014; MONTEIRO *et al.*, 2017; RODRIGUES *et al.*, 2016; SKOWRON *et al.*, 2014). Nevertheless, the UV-C doses needed to decrease microbial growth and their metabolites (e.g., TVB-N, ammonia, biogenic amines) may accelerate oxidative reactions such as lipid oxidation, which generates off-flavor compounds responsible for loss of fish quality (MOLINA *et al.*, 2014; MONTEIRO *et al.*, 2018; MONTEIRO *et al.*, 2019). This effect on quality depends mainly on the type of product and dose applied (KOUTCHMA; FORNEY; MORARU, 2009; RIZZOTTI *et al.*, 2015).

As few studies have examined UV-C application to striped catfish (*P. hypophthalmus*), the present study evaluated the effect of UV-C light on the physicochemical quality parameters of striped catfish stored at 4 °C for 9 days.

MATERIALS AND METHODS

SAMPLE CONDITIONS

Three packages (1 kg each) of frozen fillets of striped catfish (*P. hypophthalmus*) from different brands were purchased from different markets in Niterói, Rio de Janeiro, Brazil. The fillets were transported on ice to the laboratory at the Fluminense Federal University in Niterói, where they were thawed overnight at 4 °C. Each package was divided into 10 sample portions (100 g each), which were individually vacuum-packed in low-density polyethylene bags, and randomly distributed into two groups: untreated samples (control) and UV-C samples (submitted to 1.95 mW/cm^2 for 90 s). All samples were analyzed in duplicate for biogenic amines (BAs), pH, lipid oxidation, total volatile bases (TVB-N), and ammonia (NH_3) on days 1, 3, 5, 7 and 9 of storage at 4 °C.

UV-C RADIATION EXPOSURE

The recommendations of Lázaro *et al.* (2014) were followed for the UV-C application. Fillet samples (100 g) were individually vacuum-packed in low-density polyethylene bags and submitted to UV-C light (1.95 mW/cm^2 for 90 s). The UV-C dose was chosen based on an effective antimicrobial effect (LÁZARO *et al.*, 2014). For generation of UV-C light, a barrel chamber with 12 UV-C lamps (6 of 30 W and 6 of 55 W; Osram GmbH, Munich, Germany) placed longitudinally and evenly spaced around the inner surface of the chamber was used. Fillet samples were placed at the geometrical center of the chamber, in a nylon net. Radiation intensity was determined using a UV radiometer (MRUR-203, Instrutherm Ltd., São Paulo, Brazil) placed inside the same polyethylene film used to package the sample. The UV-C light was applied in a dark room to minimize bacterial photo-reactivation.

BIOGENIC AMINES

Histamine, cadaverine, putrescine, spermine, and spermidine were quantified following the recommendations of Lázaro *et al.* (2013), Lázaro and Conte Junior (2013), and Baptista *et al.* (2014). Briefly, 5 g of sample was mixed with 5 mL of perchloric acid (5%), and the mixture was stored at 2 °C for 1 h, with stirring every 10 min. The solution was filtered (Whatman nº 1) and alkalinized with sodium hydroxide (2 N) to pH ≥ 6, kept in an ice bath for 20 min, and again filtered and alkalinized as previously described to pH ≥ 12. Then, the solution was derivatized with 20 µL of benzoyl chloride (99%), homogenized, and maintained at room temperature for 20 min. One mL of diethyl ether (99%) was added, the supernatant was removed, the remaining solution was evaporated in a nitrogen stream through a DB-3 sample concentrator (Techne, Staffordshire, UK), and then re-suspended in the mobile phase composed of acetonitrile and ultrapure water (42:58; v/v). Chromatographic conditions included a Prominence UFLC apparatus (Shimadzu, Kyoto, Japan) equipped with a Teknokroma Extrasil Tracer ODS2 (15 × 0.46 cm, 5 µm) column. Analyses were performed in an isocratic condition, with a UV detector at 198 nm. The mobile phase was a mixture of acetonitrile (Tedia, Fairfield, Ohio, USA) and ultrapure water (Millipore, Bedford, Massachusetts, USA) at 42:58 (v/v). A flow rate of 1 mL/min, an injection volume of 20 µL, a column temperature of 20 °C, and a running time of 15 min were used.

TOTAL VOLATILE BASIC NITROGEN AND pH

Total volatile basic nitrogen (TVB-N) was determined according to AOAC procedure 920.03 (AOAC, 2000). The pH levels were measured in a homogenized mixture containing 10 g of sample and 10 mL of distilled water (CONTE-JÚNIOR; FERNÁNDEZ; MANO, 2008), using a digital pH meter equipped with a DME-R12 electrode (Digimed®, São Paulo, Brazil).

AMMONIA

Ammonia was measured by the colorimetric method described by McCullough (1967), with modifications (RODRIGUES *et al.*, 2016). Nessler's reagent (Merk, Darmstadt, Germany) and Ultrapure water (Millipore, Molsheim, France) were added to the supernatant from the sample. The mixture was homogenized for 30 s in a vortex mixer (Braun Biotech International, Melsungen, Germany), and absorbance values were immediately read at 425 nm, using a UV-1800 spectrophotometer (Shimadzu, Kyoto, Japan). The ammonia concentration was calculated through a calibration curve based on different concentrations of an ammonia standard (1, 2.5, 5, 7.5, 10, 12.5, and 15 µg NH_3/g).

LIPID OXIDATION

Malondialdehyde (MDA) levels were determined using the distillation method and 2-thiobarbituric acid (Merck, Darmstadt, Germany), according to Tarladgis *et al.* (1960). The absorbance values were determined at 538 nm against a blank containing 5 mL of distilled water and 5 mL of 0.02 M 2-thiobarbituric acid solution. Results were expressed in mg MDA/kg after multiplying the absorbance by 7.8, as recommended by Tarladgis *et al.* (1960).

STATISTICAL ANALYSIS

One-way ANOVA with Tukey's test ($P < 0.05$) was performed to evaluate separately the differences between means of the treatments (control and UV-C) and days of storage (1, 3, 5, 7, and 9). The statistical analyses were carried out through XLSTAT software, version 2012.6.08 (Addinsoft, New York, NY, USA).

RESULTS AND DISCUSSION

BIOGENIC AMINES

The results for biogenic amines (histamine, cadaverine, putrescine, spermine, and spermidine) are shown in Figure 1. In untreated fillets, levels of cadaverine (Figure 1b), putrescine (Figure 1c), and spermine (Figure 1d) gradually increased ($P < 0.05$) from day 5 of storage to the end of the experiment. Also, levels of histamine (Figure 1a) increased ($P < 0.05$) on day 9, and spermidine (Figure 1e) increased ($P < 0.05$) over the entire storage period. In contrast, in UV-C-treated fillets, histamine and putrescine levels remained constant ($P > 0.05$) throughout the storage period. Cadaverine and spermidine levels slowly increased ($P < 0.05$) during the storage, and the levels of both biogenic amines were higher ($P < 0.05$) on day 9 than on day 5. Regardless of the storage period, UV-C-treated fillets maintained lower ($P < 0.05$)

histamine, putrescine, and spermine levels than untreated fillets during the storage period. No difference was observed ($P > 0.05$) between untreated, and UV-C-treated fillets for cadaverine on days 1 and 3, and for spermidine on day 1. After this period, both cadaverine and spermidine levels were lower ($P < 0.05$) in UV-C-treated fillets than in untreated fillets.

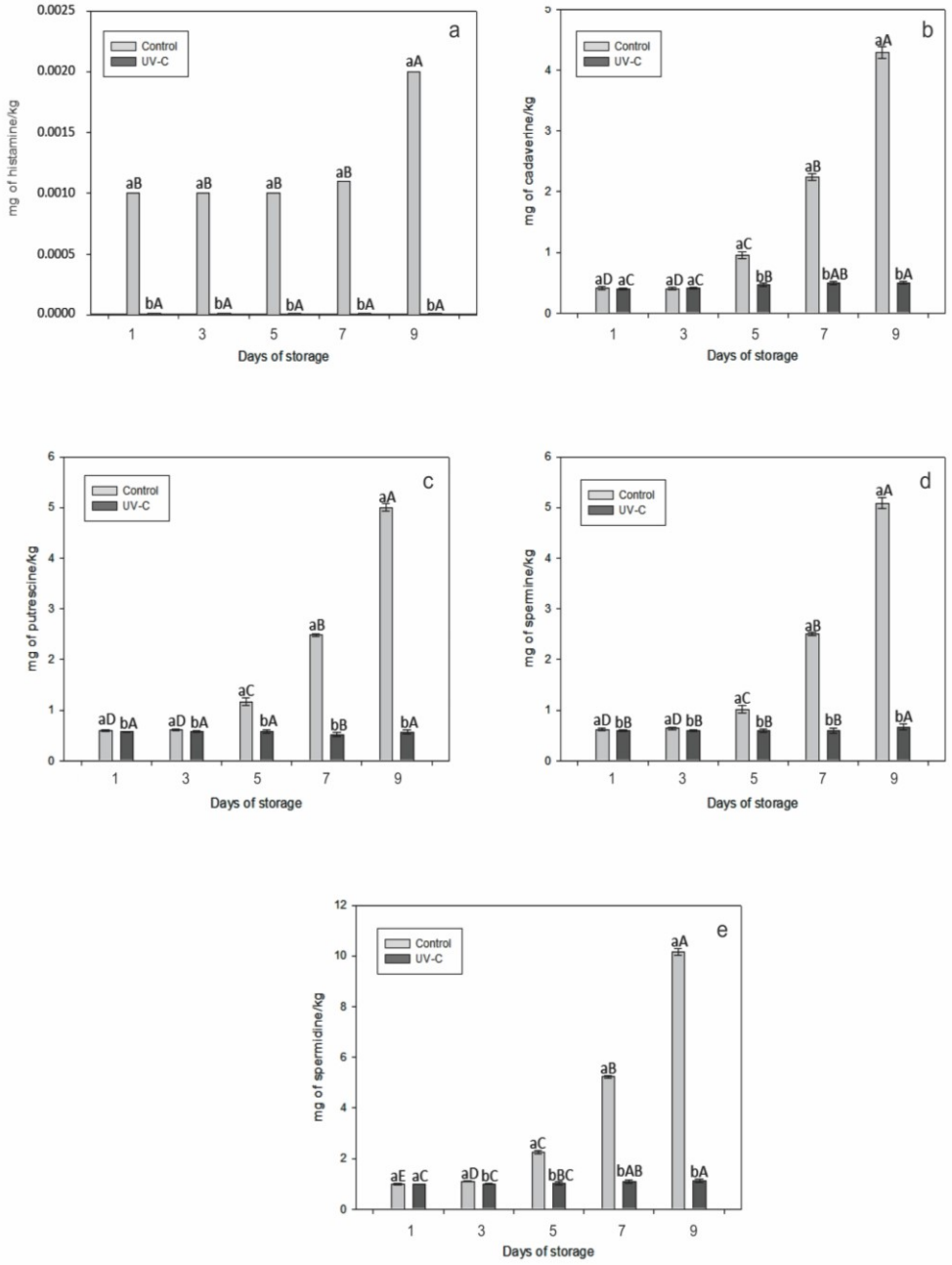

Figure 1. Levels of histamine (a), cadaverine (b), putrescine (c), spermine (d) and spermidine (e) of untreated and UV-C treated striped catfish (*P. hypophthalmus*) fillets during 9 days at 4 °C.

NOTE: Values are mean ± standard deviation (n = 3); Lowercase letters indicate significant differences ($P < 0.05$) between treatments within same day of storage; Capital letters indicate significant differences ($P < 0.05$) amongst days of storage within same treatment.

Biogenic amines are produced by decarboxylation of amino acids, mainly by the action of exogenous enzymes from spoilage-bacteria groups (HALÁSZ *et al.*, 1994). The formation of biogenic amines depends mainly on the composition of amino acids, presence of microorganisms with positive decarboxylase activity, and extrinsic factors such as handling and storage conditions, especially temperature and time (RODTONG; NAWONG; YONGSAWATDIGUL, 2005). Nevertheless, levels of biogenic amines usually increase in fish stored under refrigeration (BOTTINO *et al.*, 2017; MONTEIRO *et al.*, 2017; RODRIGUES *et al.*, 2016).

Although the UV-C radiation is able to decrease the microbial load (KOUTCHMA; FORNEY; MORARU, 2009), leading to lower levels of biogenic amines, the antibacterial effect depends on parameters such as strain, growth media, density of microorganisms, type of food, and dose used (GUERRERO-BELTRÁN; BARBOSA-CÁNOVAS, 2004; KOUTCHMA; FORNEY; MORARU, 2009; RIZZOTTI *et al.*, 2015). There is limited information about the formation of biogenic amines during refrigerated storage of fish treated with UV-C (BOTTINO *et al.*, 2017; MONTEIRO *et al.*, 2018; RODRIGUES *et al.*, 2016; SANTOS *et al.*, 2018); however, our results indicated that UV-C radiation reduced the formation of biogenic amines in striped catfish (*P. hypophthalmus*) fillets stored under refrigeration. Similarly to our findings, Monteiro *et al.* (2017) observed that UV-C radiation delayed the formation of biogenic amines in Nile tilapia (*Oreochromis niloticus*) fillets stored at 4 °C for 11 days. In contrast, Rodrigues *et al.* (2016) and Bottino *et al.* (2017) found that biogenic amines increased in rainbow trout (*Oncorhynchus mykiss*) fillets treated with UV-C radiation and stored for 22 days at 4 °C, and in tambacu (*Colossoma macropomum × Piaractus mesopotamicus*) fillets stored at 4 °C for 6 days, respectively.

Among biogenic amines, the histamine level is most commonly monitored due to its relationship to food intoxication/poisoning, which causes diarrhea, nausea, vomiting, rash, headaches, edema, hypotension, flushing, and palpitations (BULUSHI *et al.*, 2009). Brazilian legislation establishes a range of 100–200 mg/kg for histamine (BRAZIL, 2011) and the European Community regulations mandate a range of 200–400 mg/kg (EC, 2013) as the upper limit for consumer safety of the fish product. In our study, the level of histamine in both untreated and UV-C-treated fillets remained below these limits (< 0.0025 mg/kg) during the entire storage period.

TOTAL VOLATILE BASIC NITROGEN AND pH

Total volatile basic nitrogen (TVB-N) levels increased ($P < 0.05$) during the entire storage period in untreated and UV-C-treated fillets; however, the UV-C samples had lower ($P < 0.05$) TVB-N levels than their control counterparts (Table 1).

TVB-N comprises ammonia, trimethylamine (TMA), and dimethylamine (DMA), which are products of protein degradation caused by enzymatic reactions and, mainly, microbial action (ERKAN; OZDEN, 2008). The TVB-N content in fish is directly related to microbiological contamination and the degree of deterioration (KULAWIK *et al.*, 2016). Although freshwater fish species contain little or none of the TMA precursor trimethylamine oxide (TMAO), increased TVB-N levels during storage are closely linked to increased ammonia levels in freshwater fish (SCHERER *et al.*, 2006). In accordance with our findings, the pattern of increase in TVB-N

levels was observed in steaks of the sutchi catfish or swai (*Pangasius sutchi*) (MOHAN; RAVISHANKAR; SRINIVASAGOPAL, 2008) and fillets of Nile tilapia (MONTEIRO *et al.*, 2012). European Community regulations accept a range of 25–35 mg of TVB-N/100 g in unprocessed fishery products (EC, 2008), while Brazilian regulations establish a maximum limit of 30 mg of TVB-N/100 g for fish (BRAZIL, 2017). In our study, the TVB-N levels of both untreated and UV-C-treated fillets remained below the limits determined by the European Community and Brazil, agreeing with previous results for TVB-N in sutchi catfish fillets (IKASARI; SURYANINGRUM, 2015; KARL *et al.*, 2010; KULAWIK *et al.*, 2016).

Table 1. Total volatile basic nitrogen (TBV-N) and pH of untreated and UV-C treated striped catfish (*P. hypophthalmus*) fillets during 9 days at 4 °C.

Days	TBV-N (TBV-N⁄ 100 g)		pH	
	Control	UV-C	Control	UV-C
1	6.79 ± 0.02^{aE}	6.08 ± 0.01^{bE}	7.52 ± 0.55^{bB}	8.22 ± 0.11^{aC}
3	7.10 ± 0.02^{aD}	6.39 ± 0.01^{bD}	7.64 ± 0.42^{bB}	8.28 ± 0.07^{aBC}
5	7.35 ± 0.01^{aC}	6.73 ± 0.02^{bC}	7.69 ± 0.40^{bB}	8.36 ± 0.06^{aAB}
7	7.86 ± 0.01^{aB}	7.24 ± 0.01^{bB}	8.14 ± 0.27^{aAB}	8.34 ± 0.04^{aABC}
9	9.28 ± 0.02^{aA}	8.68 ± 0.02^{bA}	8.61 ± 0.26^{aA}	8.45 ± 0.07^{aA}

NOTE: Values are mean ± standard deviation (n = 3); Lowercase and capital letters indicate significant differences in the same row and column ($P < 0.05$), respectively.

To the best of our knowledge, no studies have examined the isolated effect of UV-C radiation on TVB-N in any food matrix. Nevertheless, the lower ($P < 0.05$) TVB-N levels in UV-C-treated fillets during refrigerated storage may be explained by the antimicrobial effect of this emerging non-thermal technology (LÁZARO *et al.*, 2014; MOLINA *et al.*, 2014; MONTEIRO *et al.*, 2017).

The pH levels increased ($P < 0.05$) during the storage period in both the untreated and UV-C-treated fillets (Table 1). Although pH levels were higher ($P < 0.05$) in UV-C-treated fillets until day 5 of storage, no difference ($P > 0.05$) was observed between untreated and UV-C-treated fillets on days 7 and 9, due to a slower increase ($P < 0.05$) in pH levels of the UV-C-treated fillets compared to the untreated fillets during the storage period. The pH levels are an important quality indicator because their increase is related to the accumulation of alkaline compounds such as ammonia and trimethylamine, affecting fish quality and consumer acceptance (MONTEIRO *et al.*, 2012; RODRIGUES *et al.*, 2013). Similarly to our findings, Mohan, Ravishankar, and Srinivasagopal (2008) reported a gradual increase of pH levels (6.31–7.01) in sutchi catfish steaks during 20 days of storage at 2 °C. Increasing pH levels (6.84–7.04) in sutchi catfish fillets stored at 0–4 °C for 18 days were also observed by Ikasari and Suryaningrum (2015). Despite the known increase in pH during storage, the variation in pH levels reported for the same fish species may be explained by different catching, processing, and storage methods (AURSAND *et al.*, 2009; ESAIASSEN *et al.*, 2004; MONTEIRO *et al.*, 2013; MONTEIRO *et al.*, 2017; MORZEL; SOHIER; DE VIS, 2003).

Regarding UV-C processing, the relatively high pH levels observed in UV-C-treated fillets until day 5 can be attributed to the ability of UV-C radiation to intensify the formation of reactive oxygen species (ROS), favoring protein oxidation and therefore the accumulation of alkaline compounds (CHAN; WU; YU, 2003;

MONTEIRO *et al.*, 2017). Contrariwise, UV-C radiation decreases bacterial growth rates, retarding the increase of pH levels during storage (LÁZARO *et al.*, 2014; MOLINA *et al.*, 2014). The same phenomenon was observed by Monteiro *et al.* (2017).

AMMONIA

The ammonia concentration increased ($P < 0.05$) in both untreated and UV-C-treated fillets during the storage period at 4 °C (Table 2). Nevertheless, UV-C-treated fillets had lower ($P < 0.05$) ammonia levels than untreated fillets during the entire storage period.

Table 2. Ammonia and lipid oxidation of untreated and UV-C treated striped catfish (*P. hypophthalmus*) fillets during 9 days at 4 °C.

Days	Ammonia (µg NH_3/g)		MDA* (mg MDA/kg)	
	Control	UV-C	Control	UV-C
1	0.36 ± 0.03^{aD}	0.10 ± 0.01^{bD}	1.73 ± 0.05^{bD}	2.03 ± 0.04^{aE}
3	0.33 ± 0.02^{aD}	0.17 ± 0.01^{bC}	2.07 ± 0.02^{bC}	2.25 ± 0.05^{aD}
5	2.26 ± 0.04^{aC}	0.17 ± 0.01^{bC}	2.12 ± 0.02^{bBC}	2.33 ± 0.02^{aC}
7	3.16 ± 0.04^{aB}	0.24 ± 0.01^{bB}	2.17 ± 0.01^{bB}	2.50 ± 0.02^{aB}
9	5.34 ± 0.06^{aA}	0.33 ± 0.03^{bA}	2.26 ± 0.04^{bA}	2.79 ± 0.04^{aA}

NOTE: Values are mean ± standard deviation (n = 3); Lowercase and capital letters indicate significant differences in the same row and column ($P < 0.05$), respectively; *MDA: malondialdehyde.

Ammonia is produced from the deamination of adenosine monophosphate (AMP) and amino acids, due to the action of autolytic enzymes and, mainly, microbial activity (PIVARNIK *et al.*, 2011). This compound is the main volatile base, and is therefore an adequate quality indicator in freshwater fish (ERKAN; OZDEN, 2008; HOWGATE, 2010) due to the low content or absence of the trimethylamine (TMA) precursor (RODRIGUES *et al.*, 2013).

In agreement with our results, an increase in ammonia levels during refrigerated storage was observed in fillets of rainbow trout (RODRIGUES *et al.*, 2016) and Nile tilapia (MONTEIRO *et al.*, 2012). The effect of UV-C radiation on ammonia concentrations in fish is little known. Brazilian and international regulations do not address ammonia concentrations, although ammonia may cause neurotoxic effects in humans (THRANE *et al.*, 2013).

Our findings suggest that UV-C radiation was effective for ammonia control in striped catfish during 9 days of storage at 4 °C. This phenomenon can be attributed to the detrimental effect of UV-C radiation on bacterial growth (LÁZARO *et al.*, 2014; MOLINA *et al.*, 2014; MONTEIRO *et al.*, 2017). Bottino *et al.* (2017) observed that UV-C treatment delayed the formation of ammonia in tambacu fillets stored at 4 °C, whereas Rodrigues *et al.* (2016) reported no effect of UV-C radiation on ammonia levels of refrigerated rainbow trout fillets. The changes caused by UV-C processing vary mainly with the type of product and dose utilized (KOUTCHMA; FORNEY; MORARU, 2009; RIZZOTTI *et al.*, 2015), explaining the differences among studies.

LIPID OXIDATION

Lipid oxidation increased ($P < 0.05$) in untreated and UV-C-treated fillets during the entire storage period (Table 2). Untreated fillets showed lower ($P < 0.05$) lipid oxidation than UV-C-treated fillets over the storage period. Lipid oxidation naturally increases during storage, due to the action of endogenous enzymes such as lipoxygenase (ABREU *et al.*, 2011) and the presence of pro-oxidants such as free iron released from protein degradation (WONGWICHIAN *et al.*, 2015). The tendency for lipid oxidation to increase in fish during refrigerated storage is well documented (KHALAFALLA; ALI; HASSAN, 2015; MONTEIRO *et al.*, 2012; MONTEIRO *et al.*, 2017; RODRIGUES *et al.*, 2016).

Although national and international legislation mandates no established limit for thiobarbituric acid-reactive substances (TBARS) levels for fish, Sallam (2007) proposed a maximum of 5 mg of malondialdehyde (MDA)/kg to indicate good quality in Pacific salmon (*Oncorhynchus nerka*). In the present study, malondialdehyde remained below this level; however, the TBARS data were high compared to studies of lipid oxidation in sutchi catfish fillets (KULAWIK *et al.*, 2016; MOHAN; RAVISHANKAR; SRINIVASAGOPAL, 2008), suggesting failure during the production chain, mainly in processing and storage, due to the susceptibility of the fish matrix to oxidation (TANIMOTO *et al.*, 2015).

Our results indicate that UV-C radiation enhanced ($P<0.05$) lipid oxidation in striped catfish fillets, which can be attributed to the action of UV-C in stimulating oxidative reactions and accelerating ROS formation (CHAN; WU; YU, 2003). Similarly to our findings, Molina *et al.* (2014) and Park and Ha (2015) observed enhanced lipid oxidation by UV-C radiation in fillets of farmed sea bass (*Dicentrarchus labrax*) and fresh chicken breast, respectively. On the other hand, UV-C radiation had no demonstrable effect on lipid oxidation of Nile tilapia fillets (MONTEIRO *et al.*, 2017), rainbow trout fillets (RODRIGUES *et al.*, 2016), or chicken meat (LÁZARO *et al.*, 2014). The differences among studies may be due to varying effects of UV-C radiation on food matrices. Although UV-C radiation acts as a pro-oxidant, the effect depends mainly on the UV-C dose and the lipid composition of the food matrix (MOLINA *et al.*, 2014; MONTEIRO *et al.*, 2017; SOUZA *et al.*, 2013).

CONCLUSIONS

UV-C radiation (1.95 mW/cm^2 for 90 s) was effective in the control of compounds derived from protein degradation, such as biogenic amines, TVB-N, and ammonia in striped catfish fillets stored at 4 °C for 9 days. However, this technology enhanced the lipid oxidation of refrigerated striped catfish fillets. Further studies are necessary to optimize the UV-C dose in this fish species, aiming to scale up this application to industrial levels.

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Efeito da radiação UV-C nos indicadores de qualidade de filés de panga (*Pangasianodon hypophthalmus*) estocados sob refrigeração

RESUMO

O panga (*Pangasianodon hypophthalmus*), exportado principalmente pelo Vietnã, tem sido amplamente aceito pelos consumidores devido a carne branca e baixo custo. Todavia, o peixe é uma matriz extremamente perecível que requer aplicação de tecnologias alternativas para garantir qualidade e inocuidade em períodos prolongados de estocagem sob refrigeração. Desta forma, o objetivo deste estudo foi investigar o efeito da radiação UV-C (1,95 mW/cm^2 por 90 s) nos parâmetros bioquímicos de qualidade de filés de peixe panga estocados a 4 °C por 9 dias. Filés de peixe panga refrigerados foram analisados em relação a aminas biogênicas, pH, bases voláteis nitrogenadas totais (N-BVT), amônia e oxidação lipídica. Os filés tratados com radiação UV-C apresentaram menores ($P < 0,05$) valores de N-BVT, amônia e aminas biogênicas e maior ($P < 0,05$) oxidação lipídica comparado com os filés não tratados durante o período de estocagem. Os filés tratados com radiação UV-C apresentaram maiores ($P < 0,05$) valores de pH do que os filés não tratados até o 5° dia de estocagem, embora ambas amostras tenham apresentado valores de pH similares ($P > 0,05$) nos dias 7 e 9. Esta tecnologia é uma possível alternativa para conservação de filés de peixe panga, entretanto, outras doses de UV-C devem ser avaliadas para minimizar ou prevenir o efeito negativo na oxidação lipídica encontrada no presente estudo.

PALAVRAS-CHAVE: Método UV-C; tecnologia emergente; parâmetros de qualidade; CLAE-DAD.

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