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ORIGINAL RESEARCH

Post-transport resting times associated with pre- and post-rigor mortis processing on the quality of patinga (*Piaractus mesopotamicus* × *Piaractus brachypomus*) fillets

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Abstract The transfer of live fish from production facilities to processing plants imposes significant stress on the animals, with negative impacts on fillet quality. Considering the numerous species of fish that exist, research into pre-slaughter handling and processing strategies that can have a beneficial impact on fillet quality can generate profitability for the production sector and a higher quality product for the consumer. This study aimed to investigate the influence of varying post-transport rest times on muscle glycogen, blood glucose and meat quality characteristics in the pre- and *post-rigor mortis* stages of patinga. An experiment was conducted in a 4 × 2 factorial design, with four transport recovery times (0, 2, 4 and 6 hours) and two processing phases (pre- and post-*rigor mortis*). Muscle glycogen levels showed an increase, accompanied by a decline in blood glucose, as rest times extended, with homeostasis being restored after 6 hours of rest. Fish processed in pre-*rigor mortis* after 6 hours of rest had fillets with greater luminosity, lower red intensity and greater firmness. Six hours of rest resulted in fillets with lower weight loss due to cooking and higher water holding capacity (WHC). Filleting post-*rigor mortis* resulted in fillets with lower cooking loss, lower luminosity, lower yellow intensity and higher WHC. Therefore, resting post-transport for 6 hours is effective for recovering from stress and has a positive impact on fillet quality. Processing patingas post-*rigor mortis* provides fillets with lower weight loss and better coloring.

Keywords Stress . Pre-slaughter Handling . *Piaractus mesopotamicus* ♀ × *Piaractus brachypomus* ♂ . Fish processing

Introduction

Transporting live fish from farms to processing plants allows immediate slaughter and processing, preserving freshness. Fish spoil quickly because of their nutritional composition (Amaral et al. 2021), which makes immediate refrigeration essential to preserve freshness and extend shelf life (Duarte et al. 2020). Thus, delivering live fish to processing plants is essential.

During transport, fish experience stress from temperature fluctuations, rapid water movement, overcrowding, and poor water quality, including low oxygen and ammonia buildup (Zhang et al. 2023). Pre-transport procedures (fasting, sorting, crowding, harvesting, handling, and loading) and post-transport activities (un-

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loading and handling) also contribute to stress (Yang et al. 2021).

Transportation and handling alter fish physiology, nutrition, and meat quality (Zhang et al. 2023). Intense physical activity reduces intracellular oxygen, triggers anaerobic glycolysis, and increases lactic acid production, which lowers muscle pH (Daskalova 2019). This pH reduction causes myosin denaturation and enhances cathepsin activity, increasing muscle proteolysis (Zhang et al. 2019). Oxidative stress further increases protein oxidation (Goes et al. 2019), leading to meat softening, gapping (Chauhan and England 2018), reduced water-holding capacity, exudate loss, and color changes (Goes et al. 2019). Additionally, stressed fish experience faster *rigor mortis* development (Roth and Skåra 2021).

Rigor mortis strongly affects fish quality and processing (Bhat et al. 2017). For most species, filleting is ideally done in the pre-rigor state (Birkeland and Akse 2010), but rapid rigor onset complicates processing during this period (Daskalova 2019). Reducing pre-slaughter stress is vital for preserving meat quality (Daskalova 2019). Post-transport resting is an effective strategy to restore homeostasis in fish after stress (Fantini et al. 2020). Processing plants provide tanks for fish to rest before entering the production line, but recovery depends on the optimal duration of rest, as both too short or too long periods may be ineffective.

Therefore, the aim of this study was to evaluate the effect of different post-transport rest times on blood glucose and meat quality characteristics in the pre- and *post-rigor mortis* stages of patinga (*Piaractus mesopotamicus* ♀ × *Piaractus brachypomus* ♂).

Materials and methods

The project was approved by the Ethics Committee on Animal Use (CEUA/UFGD) at the Federal University of Grande Dourados, protocol no. 09.2021.

Experimental animals

Fish were obtained from a commercial farm in Ponta Porã, MS, Brazil. Seventy-five patinga specimens (*Piaractus mesopotamicus* ♀ × *Piaractus brachypomus* ♂), were used, with an average weight of 1.81 ± 0.36 kg. Before harvesting, all the fish were fasted for 48 hours to empty their digestive tracts.

Experimental design

The experiment followed a 4 × 2 factorial design, with four recovery times (0, 2, 4, and 6 h) and two processing phases (pre- and *post-rigor mortis*), plus a control treatment (15 fish removed from the hatchery and immediately euthanized by sectioning the spinal cord), resulting in a total of 9 treatments. Fifteen fish were sampled per recovery time, totaling 75 fish. From each recovery time, 10 fish were processed during the pre-rigor *mortis* period and, 24 hours later, after *rigor mortis* had resolved, a further 5 fish per treatment were processed (in the *post-rigor mortis* phase).

For the control treatment samples, the fish were removed from the pond using a trawl net, blood was collected through caudal puncture, and the fish were euthanized by sectioning the spinal cord. Fish were packed in ice and transported to the processing plant.

The other fish were transported in vivo. To do this, after harvesting, the animals were weighed on a portable scale and placed in a transport box at a density of 225 kg of fish/m³. A box suitable for transporting live fish was used, made of fiberglass and with a capacity of 500 liters, equipped with a diffuser and oxygen cylinder. The transport box was filled with clean water from an artesian well. Sodium chloride (6 mg L^{-1}) was added to the transport water, and the temperature was lowered with ice and maintained at 21 ± 1 °C (Kubitza 2009). Temperature and oxygen saturation levels during transport were tracked using a portable meter.

The transport box, packed in a van, was transported for one hour between the harvesting and processing plants. After transport, 15 fish were sampled from the 0-hour treatment, and the remaining animals were distributed into three 2000-liter water tanks, with each tank corresponding to a treatment (2, 4 and 6 hours of rest after transport). Fifteen fish were placed in each tank, which was connected to a recirculating water system, located at the Aquaculture Area Laboratory of the Faculty of Agricultural Sciences of Federal University of Grande Dourados (22°11’52” S 54°55’59” W; 463 m).

Fish from each treatment (0, 2, 4, and 6 h of post-transport rest) underwent blood collection by caudal venipuncture and were euthanized by spinal cord section, packed in ice and taken to the processing plant.

The pre-*rigor mortis* fish (n=10 per treatment) were processed immediately, while the post-*rigor mortis* fish (n=5 per treatment) were stored whole in a refrigerator (±5°C) for 24 hours and then processed to remove the fillets. To confirm that rigor mortis had fully resolved before post-rigor processing, a rigor index analysis was performed based on the method proposed by Bito et al. (1983). This involved assessing body stiffness and calculating the index based on changes in body curvature. Fish that presented a rigor index of 0 were considered to be in the post-rigor state.

For this procedure, the fish were scaled manually, and the abdominal cavity was opened ventrally, from the urogenital opening to the jaw bones. The viscera were then carefully removed. Afterward, the fish were decapitated and filleted by hand.

The entire skin-on fillets were rinsed in chlorinated water, and a sample of the white dorsal muscle (± 5 g) was collected for glycogen content analysis. Finally, the fillets were individually packed in Styrofoam trays and labeled plastic bags and refrigerated (± 4ºC) until the time of analysis.

All the analyses of meat quality parameters were carried out 24 hours after slaughter, on the fillets from the direct side of the fish. A flowchart summarizing the entire experimental process is presented below (Figure 1).

Determination of blood glucose and muscle glycogen content

Blood was collected from each fish (n=15 per treatment) by tail puncture, using disposable heparinized syringes, with a volume of 2 mL per fish. The glucose concentration was determined using an electronic blood glucose meter (Accu-Chek Advantage II / Roche), where 10 µl of whole blood were placed on the meter's reading strips which, by means of an electrochemical analysis of the sample, showed the glucose concentration in g dL^{-1}.

The muscle glycogen content was determined using the method described by Bidinotto et al. (1997). Briefly, approximately 0.5 g of white dorsal muscle was homogenized in 30% KOH, boiled for 20 minutes to solubilize glycogen, and then cooled. Ethanol (95%) was added to precipitate glycogen, followed by centrifugation at 3,000 × g for 15 minutes. The supernatant was discarded, and the pellet was washed with

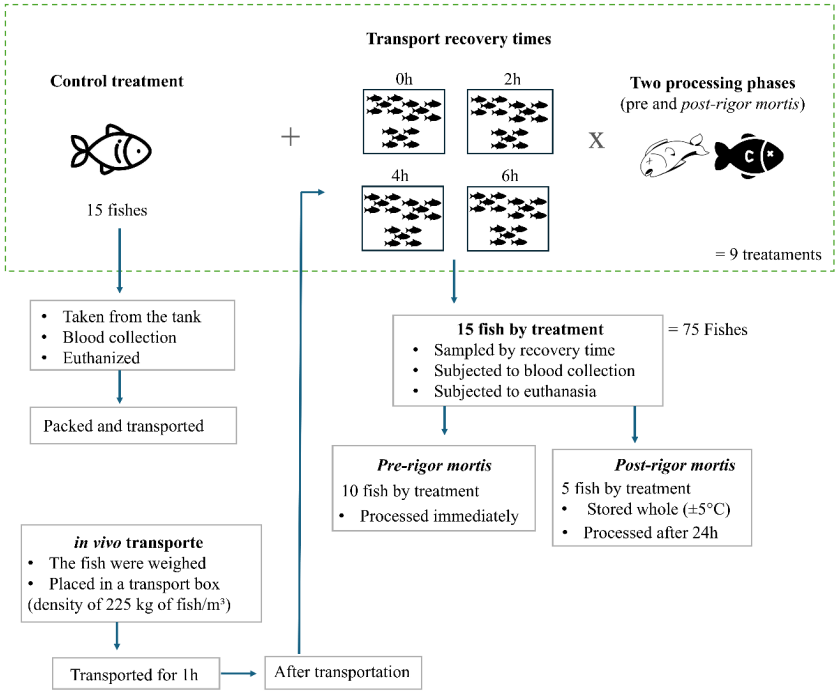

Fig 1. Flowchart summarizing the entire experimental process

70% ethanol, recentrifuged, and then resuspended in distilled water. Glycogen was quantified spectrophotometrically using the phenol-sulfuric acid method, with absorbance measured at 490 nm. Results were expressed as mg glycogen per g of muscle tissue.

Fillet quality parameters

The pH, color, water holding capacity, water loss due to cooking and shear force were analyzed in 10 fillets processed *pre-rigor* and 5 fillets processed *post-rigor mortis*, by transport recovery time. All analyses were carried out 24 hours *post-mortem*. All fillet samples, regardless of the rigor mortis status at the time of processing, were stored under identical refrigerated conditions (±4ºC) for 24 hours post-mortem before analyses. This approach was adopted to standardize the aging period and enable reliable comparisons between pre- and post-rigor groups based on the physiological state of the fish at the time of filleting.

The pH was measured in triplicate per fillet using a portable digital potentiometer (Testo® model 205) equipped with an insertion electrode designed for meat.

The brightness measurements were taken on the ventral side of the fillet at six different reading points per sample. The luminosity values (L*) will be evaluated using a colorimeter (Minolta® model CR-10), at an angle of 90°, at room temperature, where L* defines luminosity (L*= 0 black and L*=100 white), chroma a* (red-green component) and chroma b* (yellow-blue component).

The water holding capacity (WHC) was carried out in triplicate, according to Barbut et al. (1996). For this purpose, 0.5 g meat samples were placed between two circular qualitative filter papers (5.5 cm in diameter, 205 µM in thickness, and 80 g/m² in weight), which were then positioned between two square glass plates, each 8 mM thick. Uniform pressure was applied to this set using a 10 kg weight for five minutes. Then, the samples were reweighed, and the difference between the final and initial weights was calculated and expressed as a percentage.

Water loss due to cooking was measured according to Cason et al. (1997). A 70.0 g meat sample was weighed, placed in plastic bags, and cooked in a water bath until the internal temperature reached 75 to 80°C, as monitored by a digital thermometer. Afterward, the samples were cooled to 30°C and reweighed. The difference between the initial and final weights was calculated and expressed as a percentage, reflecting the water loss due to cooking. The tenderness of the fillets was assessed by measuring the resistance to cutting (shear force). A Stable Micro Systems Texture Analyzer (model TA-XT Plus) was used for this, equipped with an SMS shear cell (Stable Micro Systems) and a Guillotine Blade (USDA) with a thickness of 3 mM, a length of 70 mM, and a 90º angle. Before analysis, the fillets were allowed to reach room temperature for approximately an hour. They were then cut into cubes of about 20x25x20 mM, transversely to the direction of the muscle fibers. The analysis was performed in triplicate per fillet, measuring the shear force parameter in Newtons (N).

Statistical analysis

A completely randomized design was used for the blood glucose and muscle glycogen results, with 4 treatments (0, 2, 4, and 6h of rest after transport) along with a control treatment. The data were analyzed using analysis of variance (ANOVA), and when significant differences were found ($P < 0.05$), Tukey's test was applied to examine differences between the means. The treatments were compared with the control mean using the Dunnet test.

The meat quality parameters were analyzed using analysis of variance (ANOVA) with the Factorial ANOVA - General Linear Models procedure, at a 5% significance level. In the case of significant differences ($P < 0.05$), Tukey's test was applied to assess differences between the means. The means of the treatments in the factorial scheme were compared to the means of the control treatment using the Dunnett test, with *pre-rigor* and *post-rigor mortis* means being analyzed separately. All data were presented as mean ± standard error of the mean. The analyses were conducted using STATISTICA 7.1® software.

Results

Muscle glycogen (Figure 2A) was lower at 0, 2, and 4 h after transport, with the highest mean observed af-

ter 6 h (P <0.001). All the rest times analyzed were significantly (P <0.001) lower than the control treatment. Blood glucose (Figure 2B) decreased as resting time increased (P <0.0001), with the highest means at 0 and 2 h and the lowest at 6 h post-transport. When comparing the average blood glucose of the fish at the different rest times with the control treatment, it was only after 6 hours of rest that the average glucose was equal to the average of the control treatment, showing that after this period the fish returned to their initial blood glucose values.

For the fillet quality parameters (Table 1), the interaction between resting time and rigor *mortis* state was significant (P <0.05) for brightness, red (a*) and yellow (b*) intensities and shear force. Fillets from patingas submitted to 6 hours of rest in a state of *pre-rigor mortis* had higher luminosity (L*) and shear force. In addition, fillets rested 4 h pre-rigor had higher redness, while those processed *post-rigor* had higher yellowness.

Evaluating only the post-transport resting time factor, significant differences were observed (P < 0.05) for water holding capacity (WHC) and cooking weight loss (CWL). The lowest WHC was observed in fish that rested for 2 hours, while the highest cooking weight losses were seen in fillets from fish that rested for 2 and 4 hours.

Analyzing only the state of *rigor mortis*, there were significant effects (P <0.05) for the parameters pH, CWL and WHC, where processing the fish *post-rigor mortis* resulted in fillets with lower pH and CWL values and higher WHC.

Comparing the averages of the factorial scheme in a *pre-rigor* state with the control treatment (pre-transport slaughter) also in a *pre-rigor* state, only the averages obtained for CWL in the control fillets were different (P > 0.05) from the others. For pH, all the averages were higher than the control in a *pre-rigor mortis* state. For red intensity and WHC, the treatment in a *pre-rigor* state with 2 hours of rest was different from the control. For luminosity and shear force, 6 hours of rest in the *pre-rigor* state was different from the control. For both the 0-hour and 6-hour *pre-cooling* treatments, the yellow intensity averages were different

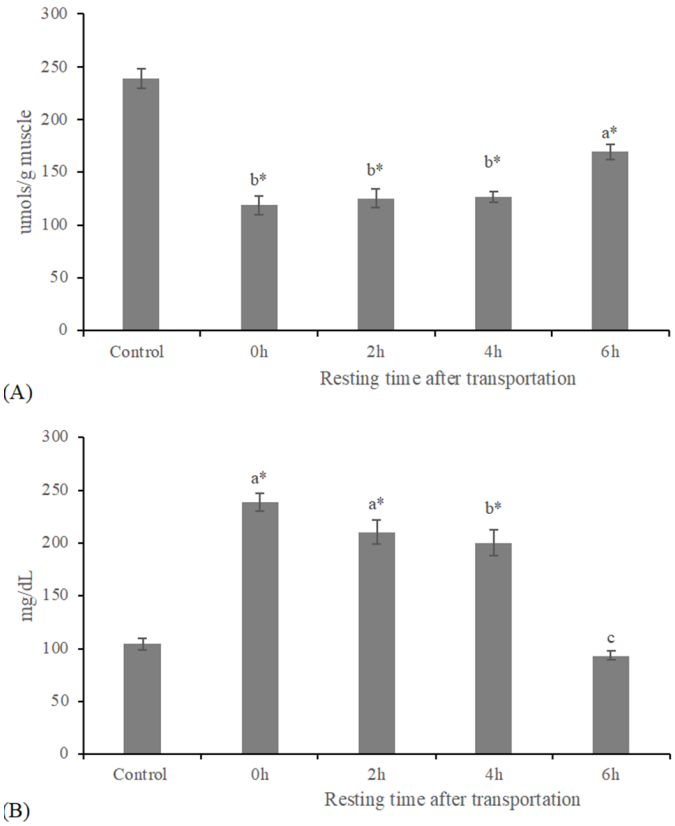

Fig. 2 (A) Muscle glycogen and (B) blood glucose of patinga subjected to different post-transport rest times. Vertical bars represent the standard error of the mean. Different letters indicate differences (P <0.0001) by Tukey's test. *Means differ from the control treatment.

Table 1 Quality parameters of patinga fillets subjected to different resting times after transportation, 24 hours after slaughter

Resting time	*Rigor mortis* status	pH	L*	a*	b*	Cooking loss (%)	Water holding capacity (%)	Shear force (N)
0h	Pre	6.25±0.02*	48.99±0.36 b	0.69±0.41 b	1.17±0.14 b*	10.58±1.05	59.32±0.27	83.00±3.43 b
	Post	6.16±0.02	49.94±0.32 ab	-0.15±0.02 b	0.05±0.02 c	10.02±0.37	63.66±0.54	103.18±6.95 ab
2h	Pre	6.25±0.04*	49.55±0.63 ab	2.12±0.40 a*	1.76±0.23 ab	13.48±0.63	56.61±0.73*	89.24±2.87 ab
	Post	6.15±0.08	48.74±1.01 ab	1.87±0.34 a#	0.58±0.24 bc	12.30±0.74	60.30±1.18	80.32±4.90 b
4h	Pre	6.26±0.03*	49.49±0.17 ab	0.97±0.23 ab	2.53±0.16 a	14.31±0.33	59.89±0.56	94.13±4.61 ab
	Post	6.12±0.07	47.99±0.43 b#	-0.46±0.28 b	1.06±0.06 bc#	10.17±0.23	61.70±1.30	85.50±1.19 ab
6h	Pre	6.25±0.03*	51.11±0.32 a*	0.11±0.22 b	1.21±0.23 b*	11.24±0.68	59.80±0.75	106.95±6.36 a*
	Post	6.07±0.02	48.84±0.65 b	0.95±0.07 ab#	1.33±0.16 b#	11.09±0.81	62.33±0.55	86.01±3.82 ab
Control (pre-transport)	Pre	6.04±0.05	48.83±0.41	1.03±0.25	2.05±0.11	13.20±0.97	60.63±1.60	88.28±4.60
	Post	6.13±0.03	50.88±0.38	-0.17±0.11	0.19±0.21	10.58±0.73	62.20±0.34	83.53±9.73
Rest times								
0h		6.21±0.02	49.27±0.30	0.38±0.28	0.80±0.21	10.37±0.65 b	60.90±0.70 a	91.07±4.61
2h		6.22±0.04	49.35±0.52	2.06±0.30	1.37±0.24	13.09±0.49 a	57.62±0.78 b	86.26±2.70
4h		6.22±0.03	49.08±0.26	0.43±0.31	2.21±0.25	13.07±0.67 a	60.39±0.56 a	91.78±3.52
6h		6.20±0.03	50.16±0.46	0.42±0.19	1.25±0.16	11.19±0.50 b	60.49±0.66 a	100.67±5.49
State of rigor								
Pre- *rigor mortis*		6.25±0.01 a	49.76±0.25	1.02±0.22	1.67±0.14	12.63±0.43 a	58.89±0.39 b	93.57±2.67
Post *rigor mortis*		6.12±0.02 b	48.87±0.35	0.53±0.26	0.76±0.16	11.00±0.39 b	62.12±0.53 a	89.18±3.42
P values								
Time		0.6447	0.1603	0.0001	0.0012	0.0073	0.0028	0.1667
State of Rigor		0.0001	0.0307	0.1179	0.0000	0.0077	0.0000	0.2355
Time*State of Rigor		0.6173	0.0470	0.0280	0.0082	0.0542	0.3935	0.0041

*Means differ from control treatment in *pre-rigor mortis*. #Means differ from control treatment in post-rigor *mortis*. L: Luminosity, a*: intensity of red, b*: intensity of yellow. Data expressed as mean ± standard error of the mean. Means in the same column followed by different letters differ according to the Tukey test (P <0.05).

from the control.

When comparing the means of the experimental treatments with the *post-rigor mortis* control, the shear force was the same for all treatments (P >0.05). As for luminosity, red intensity and yellow intensity, the averages differed from the post-rigor control, with luminosity being different for the 4-hour rest period; red intensity for the 2 and 6-hour rest periods; and yellow intensity for the 4 and 6-hour rest periods.

Discussion

Acute stress significantly influences hydromineral balance, respiratory processes, and cardiovascular health. A key aspect of the stress response is the hormone-driven mobilization of energy reserves, mainly stored as glycogen (Rodnick and Planas 2016). Stress hormones, such as cortisol and catecholamines, released by the endocrine system as part of the primary response to stress, trigger gluconeogenesis, a secondary response. This process increases glucose production and its release from the liver into the bloodstream, resulting in hyperglycemia in fish (Nakano et al. 2014). Therefore, blood glucose is considered a reliable indicator of the secondary response to physiological stress (Nakano et al. 2014; Odhiambo et al. 2020).

This study revealed an interaction between muscle glycogen and blood glucose. Higher glycogen coincided with lower glucose in the control and after 6 h of recovery from transport. Conversely, fish subjected to 0, 2, and 4 hours of rest exhibited an increase in blood glucose levels alongside a decrease in glycogen stores, likely indicating heightened glycogenolysis in these animals (Anigol et al. 2023). In fish, the stress response is typically marked by heightened muscle activity, resulting in the substantial depletion of energy reserves within the muscles (Daskalova 2019), represented by glycogen. Lower muscle glycogen levels cause rigor mortis to occur more quickly (Daskalova 2019), which is detrimental to meat processing and quality.

In this study, it was observed that after 4 hours and 6 hours of post-transport rest, the animals had gradually reduced their stress. However, it can be inferred that only after 6 hours had the animals fully recovered from the stress suffered during the transportation period, since only in this treatment were the glucose levels similar to the control. In fact, Pankhurst (2011) proposes that recovery from acute stress for most species occurs over a period of around 6 hours, and longer recovery periods can occur depending on the animal's condition. Analysis of the quality parameters 24 h after slaughter showed that, in general, the fillets had a higher pH during the *pre-rigor mortis* stage than during the *post-rigor* stage. It is known that pH in fish decreases as *rigor mortis* progresses and reaches slightly lower values than *pre-rigor* (Contreras-Guzmán 1994), as observed in this study.

Post-mortem muscle pH is commonly measured in studies investigating the impact of pre-slaughter handling on rigor mortis progression and overall fish quality (Skjold et al. 2020). Under prolonged or repeated stress conditions, lactic acid generated from anaerobic glycolysis is released, and energy reserves are progressively exhausted (Rotabakk et al. 2018). As a result, a rapid decline in muscle pH can cause the denaturation of myofibrillar and sarcoplasmic proteins (Rotabakk et al. 2018). This heightened protein denaturation subsequently reduces the meat's water-holding capacity (Olsson et al. 2003). However, in this study, it was not possible to correlate the levels of pre-slaughter stress with the pH of the fillets measured after 24 hours, since there were no significant differences for the post-transport rest times. The measurements would probably have been more accurate if they had been taken at the time of slaughter, since these pH values vary during the conversion of muscle into meat. Given that pH is a dynamic post-mortem parameter that typically declines within the first few hours after death, its measurement at a single late time point (24 h) may not capture transient but relevant differences among treatments. Future studies should measure pH immediately post-mortem and during rigor development to clarify pH decline kinetics and its link to stress recovery and meat quality.

The pH value at the time of slaughter, the rate at which it declines thereafter, and the final post-rigor pH are all known to significantly influence meat quality (Skjold et al. 2020). Thus, considering the effects observed on the other meat quality parameters, it is possible that the rate of pH decline may be more related to the effects on the other quality parameters than just the pH value after rigor mortis has been resolved. In this regard, several studies have indicated that the pH measured 24 hours after slaughter may not be influenced by varying levels of pre-slaughter stress, even though such stress can impact other meat quality traits (Goes et al. 2015; Goes et al. 2018; Zuanazzi et al. 2018). The pH of the muscle plays an important role

in the quality of the fish, as it affects the water retention capacity and textural properties of the products, influencing the solubility and functionality of the proteins (Zhang et al. 2017).

The 6-hour rest period before slaughter was effective for processing lighter fillets in the *pre-rigor* state. On the other hand, processing the animals with two hours of rest increased the red intensity of the fillets, which could be detrimental to their acceptance. In fish, the superficial lateral red muscle, which contains high levels of myoglobin, shows a strong color (typically brown), while the white muscle remains mostly translucent (Listrat et al. 2016). Muscle coloration in fish is influenced by several factors, including chemical composition, species, storage or handling methods, processing conditions, lipid and protein oxidation, pH levels, and microbial contamination, all of which occur during post-slaughter handling and storage (Singh et al. 2022). Unwanted color changes in fish muscle during processing or storage can result in consumer rejection, potentially leading to significant economic losses for the meat processing industry (Singh et al. 2022).

Another key quality parameter is meat texture. Unlike livestock, higher-quality fish fillets are valued for firmness and cohesion rather than tenderness (Wang et al. 2024). In this study, when the animals were less stressed (within 6 hours of rest), pre-rigor mortis processing led to firmer fillets. The opposite was also observed, since pre-rig processing when there was no post-transport rest (higher stress index) led to fillets with a very soft texture. The physical stress on myofibrils and connective tissues due to intense muscle activity before slaughter enhances the activation of muscle proteases, leading to the softening of the meat (Hultmann et al. 2012; Zhang 2017; Daskalova 2019).

A controversial effect was observed in cooking weight loss. Fish that were more stressed (treatment 0) and also after returning to homeostasis (after 6 h of rest) showed similar cooking weight loss. It was expected that the greatest weight loss would be observed in fish that had not undergone post-transport rest. For example, cod subjected to stressful handling before harvest exhibited a quicker onset of rigor, lower initial shear force, and higher drip loss compared to fish that were not stressed (Bjørnevik and Solbakken 2010). In fillets, exudate loss is likely linked to a decrease in muscle pH, which induces protein denaturation and reduces their solubility. This process diminishes the water-holding capacity, leads to the loss of muscle components, and impacts enzymatic functionality (Refaey et al. 2017). Thus, more studies are needed to elucidate the effect of stress on muscle pH immediately after slaughter and cooking losses in patinga fillets.

It is important to highlight the findings for fish filleted post-rigor. Regardless of resting, post-rigor processing yielded fillets with lower luminosity, lower redness and yellowness, less cooking loss, and higher water-holding capacity. These results are in line with a previous study on the fish *Pangasius hypophthalmus*, which showed that *post-rigor* processing led to higher fillet yields, more homogeneous coloration, less fillet length contraction and reduced loss of exudates (Le et al. 2020). Thus, the results obtained for patinga also show that there may be advantages to post-rigor processing over pre-rigor mortis processing. For the industry, this would necessitate a large refrigeration area to hold the fish after exsanguination, allowing them to undergo the rigor mortis process before filleting (Le et al. 2020). Another important factor to consider is microbial growth, as filleting during the pre-rigor phase may be linked to slower bacterial growth (Tobiassen et al. 2006; Duran et al. 2008), resulting in a longer shelf life for fillets.

Conclusion

In conclusion, post-transport rest time significantly influenced physiological recovery and meat quality of *patinga*. A 6-hour resting period was effective in restoring homeostasis, as evidenced by increased muscle glycogen and reduced blood glucose levels, and resulted in fillets with improved color, greater firmness, and lower cooking loss, particularly when processed pre-rigor. In contrast, post-rigor processing yielded fillets with lower luminosity and better water retention, regardless of resting time. These findings contribute new insights specific to *patinga* and offer practical recommendations for the aquaculture industry regarding optimal timing for slaughter and processing. Future studies are needed to evaluate the impact of rigor stage on the microbial load and oxidative stability of fillets during storage, in order to provide a more comprehensive assessment of product quality and shelf life.

Competing interest Authors declare that they have no conflict of interest.

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