THERMAL STRESS AND TRANSPORT DENSITY: INFLUENCES ON TILAPIA (OREOCHROMIS NILOTICUS) FILLET QUALITY

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I. INTRODUCTION

Pre-slaughter transportation is an important stage in the aquaculture process, where inadequate density can cause significant stress, directly affecting fillet quality. Studies indicate that stressful handling during transportation, including catching, loading, high density in tanks, and temperature fluctuations, provoke adaptive physiological responses in fish, influencing their health and well-being [1]. During periods of stress, energy supply is regulated, resulting in delayed rigor mortis, which is determinant for maintaining freshness and meat quality. Preventing rapid autolysis, which compromises the texture, juiciness, and shelf life of the product, is essential to ensure efficient processing and high-quality fillets [2]. Therefore, this study aimed to evaluate the effects of different densities in the pre-slaughter transportation of tilapia in winter and summer on fillet quality.

II. MATERIALS AND METHODS

One hundred eighty Premium® tilapia (*Oreochromis niloticus*) were used, with an average weight of 930 ± 150 g and an average length of 37 ± 3 cm. The fish were transported in 1000 L fiberglass tanks, equipped with diffusers and oxygen cylinders, for an average distance of 100 km over 1.5 hours. The experimental design was completely randomized in a 3 × 2 factorial scheme, with three densities (375, 425, and 475 kg/m³) and two seasons (summer and winter). After arriving at the slaughterhouse, the fish were stunned with benzocaine (1 g/10 mL of alcohol/10 L of water) and euthanized by spinal cord dissection, followed by evisceration and analysis of the left fillet. The pH was measured using a portable pH meter (Testo, model 205). Color was assessed at three different points on the fillet using a portable colorimeter (Minolta CR-10™) according to the CIE L*, a*, b* system. Water holding capacity was determined according to [3]. The data were tested for normality (Shapiro-Wilk, $p < 0.05$) and homogeneity of variances (Bartlett, $p < 0.05$), followed by analysis of variance and Tukey's test ($p < 0.05$), using STATISTICA® software.

III. RESULTS AND DISCUSSION

Fish transported at a density of 375 kg/m³ in winter showed the lowest pH value, followed by fish transported at 475 kg/m³, which did not differ from fish kept at 425 kg/m³, both also in winter (Figure 1a). The reduction in pH, indicative of greater *post-mortem* lactic acid production, results in greater acidification of the muscle. This phenomenon was exacerbated by thermal stress in winter, especially at lower densities, which do not adequately maintain the fish's body temperature [4]. Water holding capacity (WHC) also varied seasonally, being lowest for fish at 425 kg/m³ in winter, followed by densities of 375 kg/m³ and 475 kg/m³ (Figure 1b). The lower WHC associated with low pH is due to the denaturation of muscle proteins and greater exudation of water to the surface of the meat, which consequently explains the higher luminosity value (L*) (Table 1) found in the animals tested in winter [5]. Regarding the red (a*) and yellow (b*) intensity parameters, the highest values were observed in summer (Table 1), reflecting the greater production of pigments in response to stress [6].

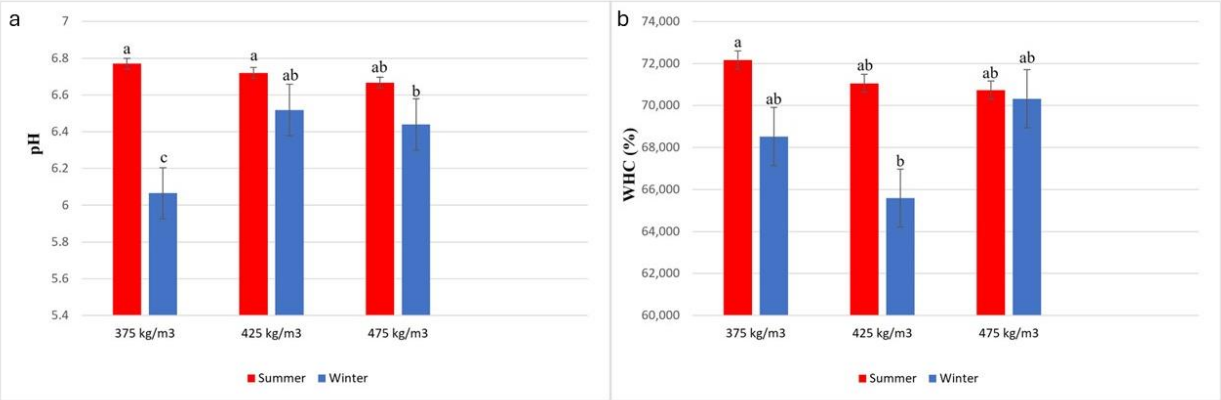

Figure 1. The bars represent the mean (± standard error) of the interaction between the variables (a) pH and (b) water retention capacity (WHC) of tilapia transported at different densities in summer and winter.

Table 1 - Mean values (± standard error) of the variables luminosity (L*), red/green hue (a*), and yellow/blue hue (b*) of tilapia transported at different densities in summer and winter.

Traits	Densities			Season		p-value		
	375 kg/m^3	425 kg/m^3	475 kg/m^3	Summer	Winter	Density	Season	DxW
L* _Surface	44.12±2.81	44.89±2.50	44.39±2.03	44.61±1.56^b	45.53±1.86^a	0.417	0.001	0.094
a*_Surface	5.56±1.59	5.77±1.94	5.33±1.53	7.05±0.88^a	4.62±1.20^b	0.581	0.000	0.649
b*_Surface	9.89±1.40	9.75±1.44	9.59±0.98	10.37±0.78^a	9.31±1.18^b	0.9742	0.029	0.596

IV. CONCLUSION

The combination of low transportation densities and lower temperatures exacerbates thermal stress, thereby compromising the final quality of the fillets. Optimal management of these factors is determinant to ensure high-quality tilapia products.

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