Request for Report for Projects Awarded in 2013 and 2014 by

Mississippi Center for Food Safety and Post-Harvest Technology

Title:

Award year: 2013

PI: Schilling

Co-PI: Allen

Collaborator: Michael Ciaramella

1. Objectives.

   The portion of study that was finished from FSI funding included examining the physiological changes in hematocrit and hemoglobin concentrations in channel catfish following various sequential harvest stress events to determine the effects they have on fillet color.

2. New Accomplishments toward objectives. Please indicate if all objectives listed were completed.

   Not applicable due to discontinued funding.

3. Objectives not accomplished and impediments to meeting objectives.

   Not applicable due to discontinued funding.

4. If continuing project, when will new and/or long term objectives be completed?

5. Students supported: Not Applicable

   a. PhDs (% FTE and name)
   b. M.S. (% FTE and name)
   c. Undergraduate (number of students)

6. Leveraged Funds: External Competitive Funding Applied and Awarded based on findings from this project. Not applicable
   a. Applied for:
      i. Funding agency
      ii. Program
      iii. Funding request ($$)
   b. Awarded:
      i. Funding agency
      ii. Program
      iii. Funding awarded ($$)

7. Outputs – In addition to the above, please populate the following sections to be included in a report to be compiled in a FSI Research Accomplishment Booklet. The project report will also be posted in a FSI website to be developed.

Please submit reports in Microsoft Word Document (except the published journal articles in pdf format) to Ms. Kaila Peggs by May 15.

Project Summary (Issue/Response)

In this box type 300—400 word project summary in 10 pt font.

During grow-out and harvest, cultured channel catfish (*Ictalurus punctatus*) experience stress through environmental conditions, sorting, grading and transport. The cumulative effects of such stress events elicit physiological changes. In meat products, pre-mortem physiological changes often result in alterations in quality. In channel catfish, pre-mortem physiological changes may lead to red fillets, which are characterized by a deep red coloration inhibiting their marketability. Red fillets are frequently observed at processing plants during summer months and are believed to be associated with stress. The effects of cumulative stress were assessed to identify culture stressors that elicit a physiological response triggering changes in fillet color. Temperature (i.e., 25°C or 33°C) and dissolved oxygen (DO, i.e., 2mg/L or >5 mg/L) were manipulated, followed by sorting and transport at high densities to elicit a stress response. Moderate heat stress (33°C, >5 mg/L) resulted in an increase in hematocrit (red blood cells). Fillet color changed following socking and transport stress, with chroma increasing and hue angle decreasing. The changes in chroma and hue angle were less pronounced in the moderate heat stress treatment. Redness (a*) increased under moderate heat stress (33°C, >5 mg/L). A darker fillet (lower L*) was observed in fish that were subjected to handling stress after rearing under moderate heat stress. Overall, data suggest an increased prevalence of red fillets at harvest in fish reared under high temperatures (33°C) with oxygen levels > 5 mg/L. Further evaluation of the effect of fish size and sock density must be performed to confirm these findings.

Project Results/Outcomes

In this box type 500—750 word summary of project results/outcomes.

Blood hematocrit increased in fillets from the 33-H treatment after socking and transport, with no other significant alterations observed among stressors within an environmental group (Figure 2). Fish reared under severe environmental conditions (33-L) had higher hematocrit than all fish reared under control conditions (25-H), regardless of additional handling stress. Interaction effects between temperature, dissolved oxygen and handling stress were not significant ($F = 3.05$, $p = 0.0676$) and evaluation of the main affects revealed dissolved oxygen was the only variable that affected hematocrit ($F = 4.99$, $p = 0.036$), with hematocrit levels in fish reared under high oxygen conditions being approximately two units lower than those reared under low oxygen.

Differences in hemoglobin content between the two temperatures examined were observed when fish were reared at low oxygen levels ($\chi^2 = 10.7874$, $p = 0.0129$) with fish reared at 33°C and low oxygen (~2.5 mg/L) having a higher hemoglobin content than those reared at 25°C and low oxygen.

Redness (a*) decreased in catfish reared under control environmental conditions after experiencing socking and transport stress (25-H-ST) compared to those experiencing just socking stress (25-H-S) at 0 h. Yellowness (b*) decreased at 0 h in fillets from the severely stressed fish (33-L-ST) when compared to controls (25-H). In general, hue angle increased in all treatments as fish progressed through the handling stressors, with the exception of fish reared under high oxygen at 33°C. Although these trends were observed they were not statistically different, likely due to high variation in hue angles among fish. A lower hue angle was observed in control fish (25-H) when compared to fish reared under low oxygen conditions and subjected to handling stress (25-L-ST and 33-L-ST) (Table 2). Minor variations in chroma intensity were recorded with fish from the 25-H-ST treatment exhibiting greater intensity than fish from the 33-H treatment.

Following 24 hours of cold storage, fillets from fish reared at 33°C and high oxygen (33-H) were darker after experiencing handling stress (33-H-S and 33-H-ST). In addition, these fillets (33-H-S and 33-H-ST) were darker than fillets from all fish experiencing socking and transport stress under all other environmental conditions, with the exception of the 25-H-S and 33-L-S treatments. In several treatments (25-H-ST, 25-L-S, 33-H-S and 33-L) fillet brightness increased from 0 h to 24 h. The main effects on brightness revealed that fish reared under low dissolved oxygen ($F= 5.17$, $p = 0.0331$) conditions were, on average, approximately one unit lighter than those reared under high oxygen conditions (Figure 3).

Redness in fillets from fish reared at 25°C with high oxygen concentrations decreased after 24 h of cold storage when subjected to socking and transport stress (25-H-ST). After 24 h at 4°C redness in fish from all environmental treatments except the 33-H treatment was lower following both socking and transport stress (ST). Redness in fish reared at 33°C with high oxygen was higher than all fish reared at 25°C after experiencing the combined socking and transport stress. On average, redness decreased in fish reared at 25°C ($F = 6.61$, $p = 0.0174$; Figure 3) and following the combined socking and transport stress ($F = 12.52$ $p = 0.0002$; Figure 3).

Stress alters the color of catfish fillets, highlighting the importance of controlling for it and understanding the effects of various stress events on fillet quality. As catfish experience the sequential harvest stressors hue angle increased, moving from more red to a yellowish color, and fillet color intensity decreased, which is preferred in catfish fillets. Thus, handling stress has beneficial effects on catfish fillet color. However, environmental conditions leading up to a stress event can alter the beneficial effects of handling. While hue angle and redness in the fish reared at 33°C with high dissolved oxygen (>5 mg/L) still decreased, it was to a lesser extent than in all other environmental conditions. This resulted in a range of color values extending further into those associated with a red color, indicating that a higher prevalence of red fillet may be observed when harvesting under these conditions. Future research should evaluate the correlations between hematocrit and hemoglobin in the blood and plasma to better understand its relationship and involvement in the formation of red fillets. Size of fish and/or sock density could also play a role in the ultimate quality of the fillets produced, warranting a more detailed evaluation of the effects of socking densities on physiological stress response and fillet quality in catfish.

Project Impacts/Benefits

In this box type 250—300 words project Impacts/Benefits statement.

Not applicable

Project Deliverables

In this box list complete citations for all publications, presentations, workshops, field days, and other deliverables that came out of this project. Please use the following style (J. of Food Sci):

1. Ciaramella, M., Allen, P.J., Schilling, M.W. 2014. Alterations in physiology and quality following cumulative stress events in cultured channel catfish. Graduate Student Research Symposium, Mississippi State University, Mississippi State, MS. February, 2014.

2. Ciaramella, M., Allen, P.J., Schilling, M.W. 2014. The affect of cumulative stress on growth and fillet quality in channel catfish. Southeastern Natural Resources Graduate Student Research Symposium, Starkville, MS. March 5, 2014.

3. Ciaramella, M., Allen, P.J., Schilling, M.W. 2014. Cumulative stress affects on growth, physiology in fillet quality in channel catfish. American Fisheries Society. MS/TN Chapter Meeting, Chase, TN, March 19th, 2014.

Graphics

Include one or two graphics (picture or figure, colored preferred) that illustrate project outcomes. Please make sure you provide labels and appropriate units for all dimensions, and a title with a brief explanation for each figure/graph.

Figure 2: Hematocrit ± standard error. The graph shows least square means for hematocrit at each stage of harvest following a one month stress trial at two temperatures (25 & 33°C) and high (H, >4 mg/L) and low (L, ~2 mg/L) oxygen concentrations. Different letters represent significant difference among treatments at $p < 0.05$ (ANOVA, n = ~30/trt).

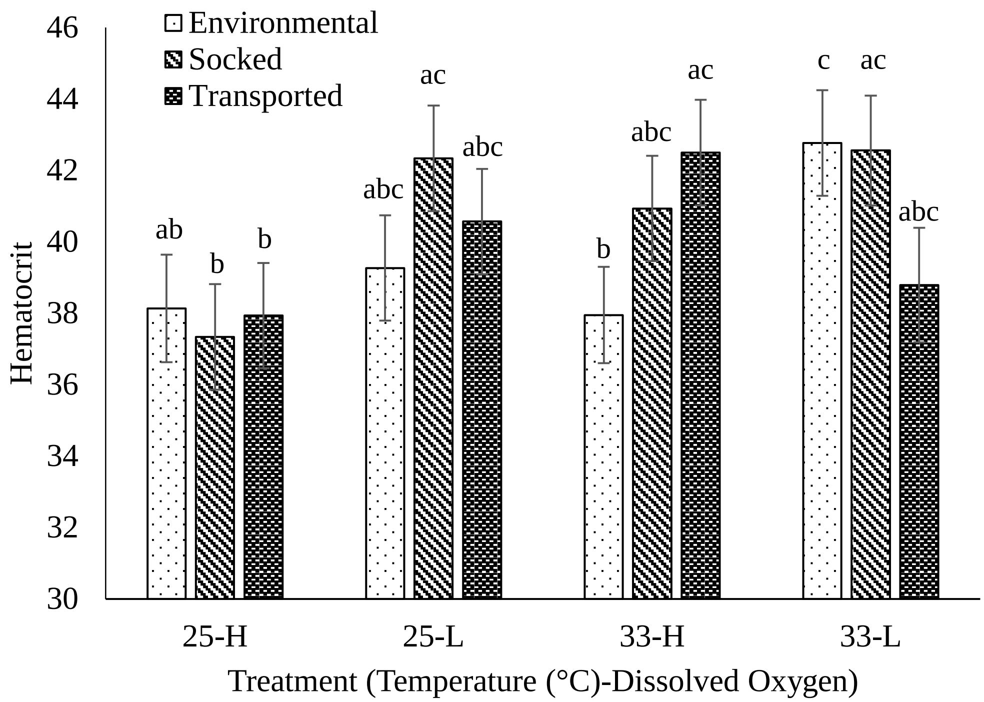
Environmental
Socked
Transported
Hematocrit
46
44
42
40
38
36
34
32
30
ab
b
b
abc
ac
abc
b
abc
ac
c
ac
abc
25-H
25-L
33-H
33-L
Treatment (Temperature (°C)-Dissolved Oxygen)

Figure 2

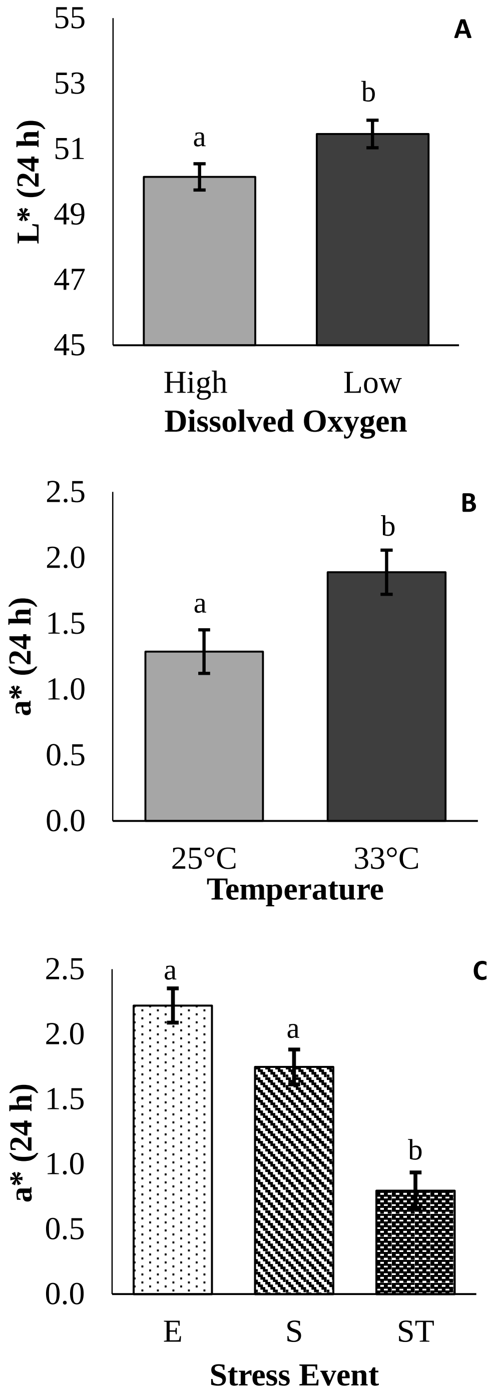

Figure 3 (A, B & C):

Figure 3: Main effects of stress treatments on brightness (L*) and redness (a*) values after 24 h of cold storage. Data represent least square means for color values ± standard error. A) Main effect of high (>5 mg/L) and low (~2.5 mg/L) oxygen levels on L* values after 4 weeks. B) Main effects of high (33°C) and low (25°C) temperatures on a* values after 4 weeks. C) Main effects of cumulative handling stressors on a* values averaged over temperature and oxygen

concentrations. Different letters represent significant differences between treatments at $p < 0.05$ (ANOVA, $n = \sim 24$).

Attached Refereed Journal Publications in Separate Files

Please attached published journal articles (in pdf format if available) for this project. Manuscripts accepted or in review process may be submitted in word files. Thank you very much for your cooperation.