Decomposition of Aquacultured Fish (Rainbow Trout and Steelhead) by Bioelectrical Impedance Analysis and Sensory Evaluations

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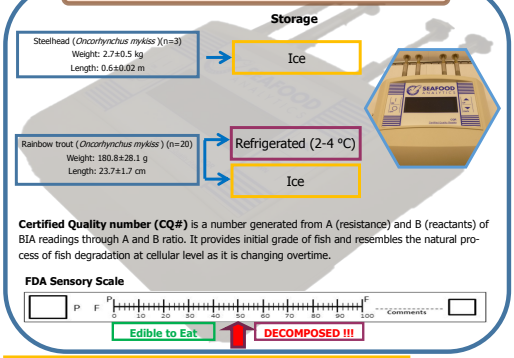
Abstract

Decomposition of fish is commonly determined using trained sensory evaluators, which is timely and expensive. Bioelectrical Impedance Analysis (BIA) is a technology that has long been utilized in the medical field to rapidly acquire body composition data. It works by sending an electrical current between to electrodes and determining electrical resistance by amount of fat and water in the body. Fat is a poorer conductor of electricity than water and it is this difference in properties that allows body composition to be estimated. Previous studies have demonstrated that these properties can also be utilized to understand the integrity of the cellular structure in muscle. The more intact the muscle cell, the more resistance. A high strength current can penetrate the muscle cells, a low strength current cannot. As muscle decomposes, a high strength current will decrease because water "leaks" from the cell and the cell becomes denser (e.g. with fats) causing increased resistance. For a low strength current, the electrical signal cannot penetrate the muscle cell and resistance is caused by extracellular fluid. A low strength current will also decrease as fish decomposes because there will be more fluid outside of the cell due to cellular leakages which reduces conduction. The objective of this project was to correlate fish decomposition as measured by BIA and sensory from time of harvest. Sensory decomposition was measured according to FDA decomposition protocols. BIA was measured using a Seafood Analytics™ Certified Quality™ Reader. Twenty rainbow trout and three wild steelhead were collected from a local hatchery. Analysis was conducted immediately after harvest, then fish were stored on ice in an insulated cooler, evaluated after 2 h, the cooler was placed in refrigerated storage (2 °C) with free drainage of melt-water, and analysis was repeated at 24 h. Rainbow trout were handled similarly, except n = 10 were also held in a stainless steel tray, loosely covered with overwrap, and placed in refrigerated storage (2 °C) without ice. Measurements were taken every 12 h the first 4 d, then every 24 h until all product was judged as being decomposed by sensory evaluators (n=3).

Material and Methods



Certified Quality number (CQ#) is a number generated from A (resistance) and B (reactants) of BIA readings through A and B ratio. It provides initial grade of fish and resembles the natural process of fish degradation at cellular level as it is changing overtime.

FDA Sensory Scale

Results and Discussion

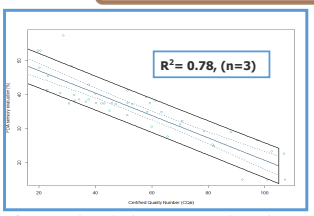


Figure 1. Relationship between CQ# reading and sensory score of Steelhead

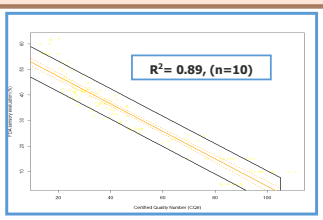


Figure 2. Relationship between CQ# reading and sensory score of Rainbow Trout stored in ice

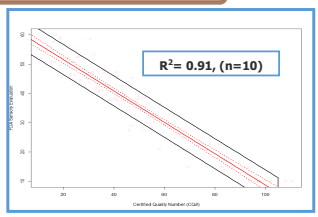


Figure 3. Relationship between CQR reading and sensory score of Rainbow Trout stored in refrigerator

- There is a strong correlation between CQ# and decomposition score of fish based on sensory assessment
- Average CQ values when all fish in decomposed stage were 22.9, 18.6, 16.5 for Steelhead and Rainbow stored on ice, Rainbow in refrigerator, respectively.
- Average CQ values when all fish just below decomposition limit were 24.9, 27.9, 28.9 for Steelhead and Rainbow stored on ice, Rainbow in refrigerator, respectively.

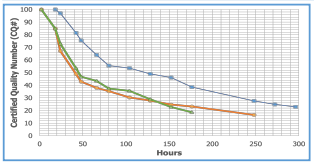


Figure 4. Certified Quality Number (CQ#) in relation to hours of storage

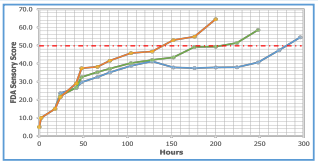


Figure 5. FDA Sensory Score in relation to hours of storage

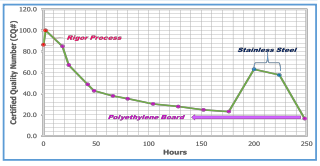


Figure 6. BIA Reading as affected by two difference surface (stainless steel and polyethylene board)

- When the decomposition score is 51, the predictive CQ# are 8.3, 13.0, 21 for Steelhead and Rainbow stored on ice, Rainbow in refrigerator, correspondingly.
- It is likely that for best practice to storage fish before further processing, we should maintain the sensory decomposition score below 40. It means the predictive CQ# for steelhead in ice, rainbow in ice, and rainbow in refrigerated storage will be 41.5, 33.5, 41.5, respectively
- One unanticipated finding was that there is significant difference in BIA reading when we changed the surface where we put those fish (Figure 6)

Conclusion

This project demonstrates that CQ# is strongly correlated with sensory decomposition score based on FDA guidance. The work suggest CQ# may be used as an effective quality control tool by seafood processors and buyers.

Acknowledgements

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