Comprehensive Insights Into Gift Tilapia (*Oreochromis Niloticus*) : Nutritional Dynamics And Growth Patterns For Informed Aquaculture And Consumer Choices

Leji j[1], Babitha G.S[2*], Sajeena Muhamed S[3]

[1,2*]Department of Zoology, Sree Narayana College, Varkala, Thiruvananthapuram -695145
[3]Department of Zoology, Iqbal College, Peringammala, Thiruvananthapuram -695563

ABSTRACT

This study delves into the vital aspects of Genetically Improved Farmed Tilapia (GIFT) (*Oreochromis niloticus*), focusing on both its growth dynamics and nutritional composition. The GIFT strain, developed through selective breeding, is pivotal in global fisheries and aquaculture. The investigation spans a 60-day experimental period, emphasizing the length-weight relationship, proximate composition, and implications for consumer nutrition and aquaculture practices.

The length-weight relationship analysis reveals a consistent and proportional growth pattern in GIFT tilapia, with varying regression coefficients indicating changes in growth dynamics. The strong correlation between length and weight and body form interpretation provides insights crucial for aquaculture and fisheries management.

Proximate composition analysis compares fresh and frozen GIFT tilapia, uncovering significant differences in total protein content. The study highlights the implications for consumer nutrition and fish feed formulation, emphasizing the importance of understanding these variations in the context of aquaculture practices.

In conclusion, this comprehensive exploration contributes valuable insights into GIFT tilapia, offering practical implications for sustainable aquaculture, fisheries management, and consumer health. Future research directions are proposed, including optimized freezing techniques and investigations into genetic factors influencing GIFT tilapia growth, aiming to enhance our understanding and promote sustainable practices in the aquaculture industry.

Keywords: GIFT Tilapia, Proximate Composition, Length-Weight Relationship, Aquaculture, Consumer Nutrition

INTRODUCTION

Fish are important to the world's economy and food supply system, and they are regarded as a nutrient source worldwide. In both domestic and foreign markets around the world, fish and its products such as canned fish, fish sticks and nuggets, smoked fish, caviar, supplements containing omega-3 fatty acids and fish oil, surimi products, fish sauce, fish meal, and fish fertilizer are indispensable. The current rate at which the world's population is using fishery resources is concerning (Costello et al., 2016; Pauly & Zeller, 2016; Worm et al., 2006). For fish resources to continue to be available for both the current and future generations, sustainable management is required.Seafood consumption is rising as a result of the growing world population. To satisfy global seafood demand and reduce strain on wild fish supplies, farmed fish is a must. Consumers can depend on this environmentally friendly method for their seafood needs (Naylor et al., 2000). It supports conservation efforts by minimizing overfishing and promoting moral aquaculture (Troell et al., 2014). Selective breeding has been used successfully in aquaculture to enhance desired traits like growth rate, disease resistance, and overall output. This method, which is driven by efforts for genetic improvement, is crucial for assessing the sustainability and output of fish farms (Gjedrem, 2000)

The present study concentrates on genetically enhanced farmed tilapia (GIFT). The Nile tilapia (*Oreochromis niloticus*) strain known as "GIFT tilapia" has been improved through selective breeding procedures to increase growth rate, illness resistance, and general productivity. Tilapias are known to display plasticity in their environment (Tibihika et al., 2018). Their development and maximum size are affected by the physical and biological makeup of their habitat (Olurin& Aderibigbe, 2006) Most farmed tilapia in India is Nile tilapia *Oreochromis niloticus*, although some *O. mossambicus* and red tilapia hybrids are cultured, especially in areas using higher salinity water for polyculture. The majority of tilapia currently produced in India are strains of Nile tilapia. The GIFT tilapia derived from the breeding program at JITRA, Malaysia, coordinated by WorldFish, were introduced to the Central Institute of Freshwater Aquaculture (CIFA) in Bhubaneswar (Singh & Lakra, 2011)) and are now the most popular of the Nile tilapia strains. This study assessed fish population dynamics and evaluated the nutritional value of GIFT Tilapia fingerlings reared in FRP (Fiber Reinforced Plastics) Tanks of 750L capacity and given protein-enriched feed.

MATERIALS AND METHODS

The genetically improved strain of Nile Tilapia (*Oreochromis niloticus*) constituted the major material for the study. 200 fingerlings (2 weeks old) of GIFT were collected from Neyyar Fisheries Hatchery and transported to the FRP tank facility of the Department of Aquatic Biology and Fisheries, University of Kerala, Kariavattom campus. The fish

were reared in the Biofloc fish tank system. Fingerlings each were stocked and reared in 2 FRP tanks of 750L capacity. Fingerlings were fed manually with commercial protein-enriched feed (Cargill aquaxcel floating fish feed of 0.6 mm, 0.8mm, 1.2 mm, and 2mm) twice every day (10.00 am and 4.00 pm). The diet contains 40% crude protein (CP). This study was carried out for 45 days.

Morphometric measurement

Fish were mopped on a filter paper before they were weighed to remove excess water from their body to ensure accuracy. Length and weight measurements were taken at an interval of 2 weeks for 45 days. The weight and length of 30 individual fish were measured with a precision of 0.00g and 0.00cm using an electronic balance measuring board, respectively. The length was measured as the distance from the snout to the tip of the caudal fin.

Length-weight relationship

The relationship between the length and weight of the fish was examined by using correlation analysis and simple linear regression. The Length-Weight relationships were calculated as per the standard methods described by (Gutreuter & Anderson, 1985)

Proximate Composition

Sample preparation

The fish samples, weighing 152 g with a Total Length (TL) of 23.2cm were chosen for freezing under -21ºC for 4 days and thawed before analysis. The second sample weighed 148.2 g with a TL of 21.7cm was taken as fresh for analyzing the proximate composition. All samples were thoroughly washed, dissected, eviscerated, and filleted using a sharp, sterile stainless-steel knife. Flesh from the consumable portion was taken for homogenization and further analysis was carried out.

Proximate Analysis

Fish samples (frozen and fresh) were subjected to proximate analysis using the methodology outlined by (AOAC, 2000) The moisture content was ascertained by drying the sample at 105 °C ± 2 °C until a constant weight was achieved, the weight difference indicates the water content in the sample, expressed in grams per 100 grams of meat. Using Kjeldahl's titration method (Sáez-Plaza et al., 2013), the total nitrogen content was obtained, and it was subsequently converted to the crude protein content to determine the protein content of the samples (Buondonno et al., 1995). Using a Soxhlet device, 200 ml of petroleum ether was used to extract the fat/lipid content from 10g of the moisture-free sample. After evaporating the extract, the fat content was calculated gravimetrically. Ash composition was determined by drying the sample at 600°C for 24 hours (AOAC, 2005).

RESULTS

GIFT Tilapia (*Oreochromis niloticus*) showed a steady and proportionate growth pattern, according to research on their length-weight connection. Based on the observed linear connection, it may be inferred that there was a predictable increase in weight with fish length. Throughout the 60-day experiment, regression coefficients, or b values, were computed at various intervals to quantify this link. Regression coefficients of 2.97, 2.8, 3.2, and 2.87 were found for sampling days 15, 30, 45, and 60, in that order. These factors show the speed at which the fish's weight varies with its length. The regression coefficients (b values), coefficients of determination (R2), and condition factor K are summarized in Table 1. The coefficient of determination and correlation coefficient often surpassed 95%, demonstrating a strong link between weight and length. This is evident in Figure 1.

The proximate composition analysis of fresh and frozen GIFT tilapia aimed to assess the percentage composition of water/moisture, protein, fat, and ash. The study involved two samples fresh and frozen fish stored at -21ºC for 4 days and thawed before analysis. Figure 2 depicts the results, indicating variations in the proximate composition between fresh and frozen samples. The moisture content was slightly higher in frozen fish (82.8 g/100g) compared to fresh fish (81.3 g/100g). The most significant difference was observed in the total protein content, with fresh fish showing a significantly higher value of 19.3 g/100g compared to 15.3 g/100g in frozen fish. Fat content showed a minor decrease from 2.8 g/100g in fresh fish to 2.6 g/100g in frozen fish, while the total ash content increased from 1.0 g/100g in fresh fish to 1.6 g/100g in frozen fish.

Table 1. The Regression coefficient, (R2), and condition factor K values of GIFT were observed during the study.

No. of days	Regression Coefficient (b)	R2	Condition factor (K)
15	2.97	0.896	0.044561598
30	2.8	0.7	0.01349
45	3.2	0.89	0.0139
60	2.87	0.95	0.0249

Figure 1.Graph showing the Length-Weight relationship of cultured GIFT obtained during the study.

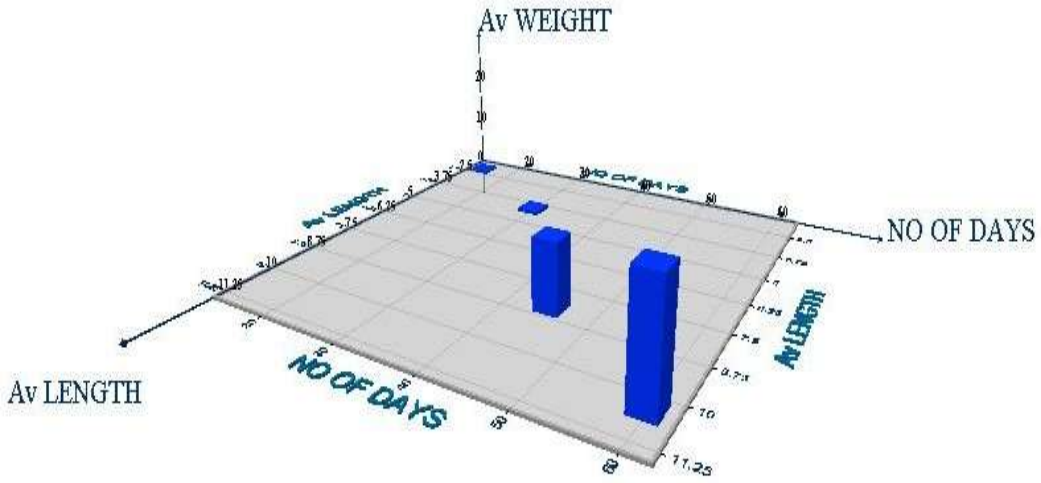
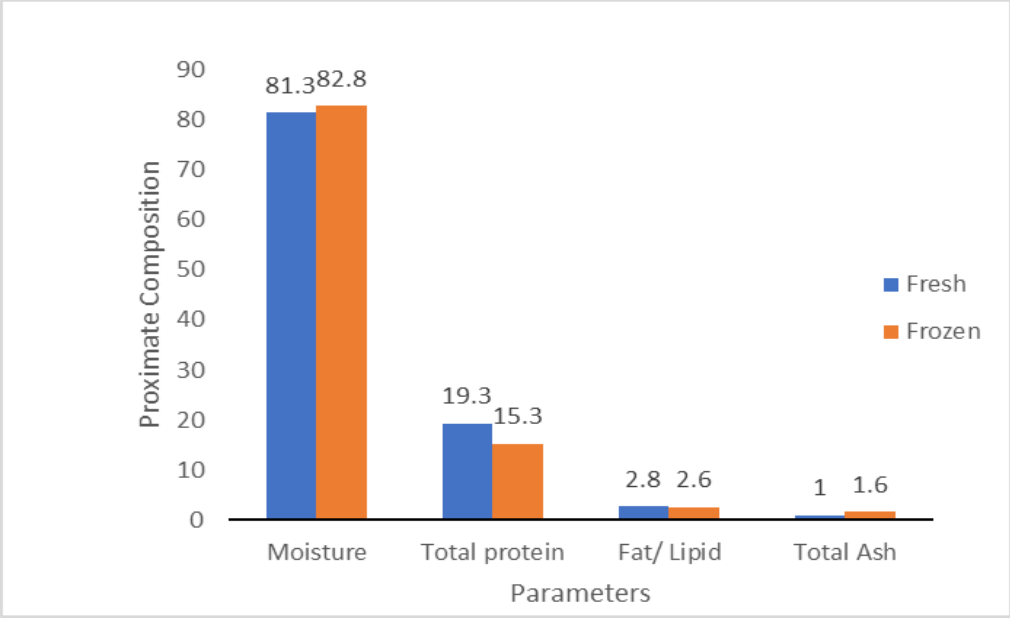


Figure 2. Proximate composition analysis of fresh and frozen GIFT tilapia.



DISCUSSION

The GIFT Tilapia length-weight connection's linear relationship suggests a steady and proportionate growth trend. The changing regression coefficients (b values) at 15, 30, 45, and 60 days indicate that the growth dynamics changed during the experiment. Fish growth patterns follow the cube law; large deviations from isometric development are rare (Beverton, R. J. H., & Holt, 1957). When fish grow in an isometric manner, this type of interaction becomes significant. However, due to the state of the fish or its surroundings, the connection between the variables length and weight may differ from this in practice (Cren, 1951).

The correlation coefficients and coefficients of determination (R2) indicated a robust and strong relationship between the length and weight of the fish. This strong correlation implies that as the fish length increases, the weight also proportionally increases. The values of b, the regression coefficients, play a key role in interpreting the body form of the fish. Fish with slender bodies tend to have b values less than 3, signifying isometry, while those with thicker bodies have b values greater than 3, indicating positive allometry (Mazumder et al., 2016). During the study, the values of b stayed less than but close to 3. The average length and weight are presented in the figure.1, during the culture period further highlight the growth trends. The increase in both average length and weight over time reflects the positive development and overall health of the GIFT tilapia. Understanding the length-weight relationship and growth patterns of GIFT tilapia is crucial for aquaculture and fisheries management. These findings contribute valuable insights into the species' development at different stages, aiding in optimizing feeding regimes and predicting biomass.

Condition factor (K) is an indicator of the well-being or fitness of fish. A higher condition factor suggests that the fish is in good condition, while a lower value may indicate potential stress or suboptimal health (Robinson et al., 2008). After 15 days of culture the condition factor was relatively higher (0.0446), indicating that, at day 15, the fish were in good condition, considering the observed length-weight relationship and regression coefficient. After 30 days of culture, the condition factor dropped to 0.0135, suggesting a potential decrease in overall fish health or fitness at day 30 compared to day 15. After 45 days of culture, the condition factor was relatively low (0.01396), indicating a potential decline in fish condition After 60 days of culture the condition factor increased to 0.0249, suggesting a recovery or improvement in fish health compared to day 30, though it's still lower than day 15.

The proximate composition analysis of GIFT tilapia, comparing fresh and frozen samples, offered valuable insights into the nutritional dynamics of the fish under different storage conditions. The study aimed to evaluate the percentage composition of essential components water/moisture, protein, fat, and ash and the findings revealed notable variations between the two sample groups. The moisture content, a critical indicator of freshness and succulence, exhibited a marginal increase in frozen fish (82.8 g/100g) compared to fresh fish (81.3 g/100g). This increment could be attributed to the freezing process, which might lead to a subtle alteration in the water content of the fish tissues (Abraha et al., 2018). The most significant disparity was observed in the total protein content. Fresh fish displayed a markedly higher protein content (19.3 g/100g) compared to frozen fish (15.3 g/100g). This decline in protein levels in frozen fish could be attributed to the potential degradation or denaturation of proteins during the freezing and thawing processes (Zhang et al., 2022). The alteration in protein content has implications for the nutritional value of the fish (Lv& Xie, 2021), with fresh fish being a richer source of dietary proteins. Previous studies done by researchers have confirmed that frozen fish have lower nutritional value than fresh fish because of the loss of protein during the freezing process (Careche et al., 1999; Mackie, 1993; Shenouda, 1980). Fat content, another essential component influencing the flavor and nutritional profile of fish, exhibited a minor decrease from 2.8 g/100g in fresh fish to 2.6 g/100g in frozen fish. This subtle change in fat content may be attributed to the storage conditions but remains within a reasonable range, indicating that the freezing process has a relatively modest impact on the fat composition of GIFT tilapia. The total ash content, representing the mineral composition of the fish, increased from 1.0 g/100g in fresh fish to 1.6 g/100g in frozen fish. This elevation in ash content could be associated with the concentration of minerals due to reduced water content during freezing. (Mazrouh, 2015).

The observed variations in proximate composition have implications for both consumer preferences and the formulation of fish-based products. The higher protein content in fresh fish underscores its nutritional superiority, making it a preferred choice for consumers seeking protein-rich dietary sources (Aberoumand, 2013; Malik et al., 2021). Additionally, the minimal changes in fat content suggest that the freezing process does not significantly compromise the lipid profile of GIFT tilapia. Further investigations could delve into the specific mechanisms influencing protein degradation during freezing, exploring ways to mitigate potential nutritional losses. Additionally, studying the impact of different freezing and thawing methods on proximate composition could provide nuanced insights for optimizing the preservation of fish quality.

CONCLUSION

In this comprehensive study, two vital aspects of GIFT tilapia (*Oreochromis niloticus*) were investigated, shedding light on its nutritional composition and growth dynamics. The proximate composition analysis revealed notable variations between fresh and frozen GIFT tilapia, with a significant decrease in total protein content in frozen samples. This finding has crucial implications for both consumer nutrition and fish feed formulation. Simultaneously, the study on the length-weight relationship of GIFT Tilapia provided insights into its growth patterns over a 60-day experimental period. The observed linear relationship and varying regression coefficients at different time points highlighted the dynamic nature of the species' growth. The strong correlation between length and weight, coupled with the body form interpretation based on regression coefficients, contributes to our understanding of GIFT tilapia's developmental characteristics.

The relevance of these findings extends to the realms of human nutrition, aquaculture practices, and fisheries management. The decrease in protein content in frozen fish raises considerations for consumer choices, while the growth dynamics data inform optimal feeding strategies in aquaculture settings. Future research endeavors could explore optimized freezing techniques to preserve the nutritional quality of frozen fish. Additionally, investigations into the genetic factors influencing GIFT Tilapia growth and studies correlating length-weight data with environmental parameters can enhance our understanding and contribute to more sustainable aquaculture practices. To conclude, the dual exploration of GIFT Tilapia's composition and growth dynamics contributes to the broader understanding of this species, offering practical implications for consumer health, aquaculture practices, and sustainable fisheries management. Practical implications for sustainable aquaculture practices and fisheries management

ACKNOWLEDGMENTS

The author would like to express gratitude to the Department of Biotechnology, Government of India, for the provision of the DBT STAR College Scheme facility to the Department of Zoology at S.N. College, Sivagiri, Varkala which has greatly contributed to ourresearch and infrastructure support.

REFERENCES

1. Aberoumand, A. (2013). Impact of freezing on nutritional composition of some less known selected fresh fishes in Iran. *International Food Research Journal*, 20(1).
2. Abraha, B., Admassu, H., Mahmud, A., Tsighe, N., Shui, X. W., & Fang, Y. (2018). Effect of processing methods on nutritional and physico-chemical composition of fish: a review. *MOJ Food Processing & Technology*, 6(4). https://doi.org/10.15406/mojfpt.2018.06.00191
3. AOAC. (2000). Official Methods of Analysis 17th Edition. Method 925. 10. *Association of Official Analytical Chemists*, Rockville, MD, USA.
4. AOAC. (2005). Official Methods of Analysis of AOAC International. In Association of Official Analysis Chemists International.
5. Beverton, R. J. H., & Holt, S. J. (1957). On the dynamics of exploited fish populations, fishery investigations series II. *Fisheries and Food*.
6. Buondonno, A., Rashad, A. A., & Coppola, E. (1995). Comparing tests for soil fertility.11. the hydrogen peroxide/sulfuric acid treatment as an alternative to the copper/selenium catalyzed digestion process for routine determination of soil nitrogen-kjeldahl. Communications in Soil Science and Plant Analysis, 26(9–10). https://doi.org/10.1080/00103629509369394
7. Careche, M., Herrero, A. M., Rodriguez-Casado, A., Del Mazo, M. L., & Carmona, P. (1999). Structural changes of hake (Merluccius merluccius L.) fillets: Effects of freezing and frozen storage. *Journal of Agricultural and Food Chemistry*, 47(3). https://doi.org/10.1021/jf9809481
8. Costello, C., Ovando, D., Clavelle, T., Kent Strauss, C., Hilborn, R., Melnychuk, M. C., Branch, T. A., Gaines, S. D., Szuwalski, C. S., Cabral, R. B., Rader, D. N., & Leland, A. (2016). Global fishery prospects under contrasting management regimes. Proceedings of the National Academy of Sciences of the United States of America, 113(18). https://doi.org/10.1073/pnas.1520420113
9. Cren, E. D. Le. (1951). The Length-Weight Relationship and Seasonal Cycle in Gonad Weight and Condition in the Perch (Perca fluviatilis). *The Journal of Animal Ecology*, 20(2). https://doi.org/10.2307/1540
10. Gjedrem, T. (2000). Genetic improvement of cold-water fish species. Aquaculture Research, 31(1). https://doi.org/10.1046/j.1365-2109.2000.00389.x
11. Gutreuter, S. J., & Anderson, R. O. (1985). Importance of Body Size to the Recruitment Process in Largemouth Bass Populations. *Transactions of the American Fisheries Society*, 114(3). https://doi.org/10.1577/1548-8659(1985)114<317:iobstt>2.0.co;2
12. Lv, Y., & Xie, J. (2021). Effects of Freeze–Thaw cycles on water migration, microstructure and protein oxidation in cuttlefish. Foods, 10(11). https://doi.org/10.3390/foods10112576
13. Mackie, I. M. (1993). The effects of freezing on flesh proteins. *Food Reviews International*, 9(4). https://doi.org/10.1080/87559129309540979
14. Malik, I. A., Elgasim, E. A., Adiamo, O. Q., Ali, A. A., & Mohamed Ahmed, I. A. (2021). Effect of frozen storage on the biochemical composition of five commercial freshwater fish species from River Nile, Sudan. *Food Science and Nutrition*, 9(7). https://doi.org/10.1002/fsn3.2340
15. Mazrouh, MM. (2015). Effects of freezing storage on the biochemical composition in muscles of Sauridaundosquamis (Richardson, 1848) comparing with imported frozen. *Fisheriesjournal.Com*, 3(2).
16. Mazumder, S. K., Das, S. K., Bakar, Y., & Ghaffar, M. A. (2016). Effects of temperature and diet on length-weight relationship and condition factor of the juvenile Malabar blood snapper (Lutjanus malabaricus Bloch & Schneider, 1801). *Journal of Zhejiang University: Science B*, 17(8). https://doi.org/10.1631/jzus.B1500251
17. Naylor, R. L., Goldburg, R. J., Primavera, J. H., Kautsky, N., Beveridge, M. C. M., Clay, J., Folke, C., Lubchenco, J., Mooney, H., & Troell, M. (2000). Effect of aquaculture on world fish supplies. In Nature (Vol. 405, Issue 6790). https://doi.org/10.1038/35016500
18. Olurin, K. B., & Aderibigbe, O. A. (2006). Length-Weight Relationship and Condition Factor of Pond Reared Juvenile Oreochromis niloticus. https://api.semanticscholar.org/CorpusID:29955244
19. Pauly, D., & Zeller, D. (2016). Catch reconstructions reveal that global marine fisheries catches are higher than reported and declining. Nature Communications, 7. https://doi.org/10.1038/ncomms10244
20. Robinson, M. L., Gomez-Raya, L., Rauw, W. M., & Peacock, M. M. (2008). Fulton's body condition factor K correlates with survival time in a thermal challenge experiment in juvenile Lahontan cutthroat trout (Oncorhynchus clarki henshawi). *Journal of Thermal Biology*, 33(6). https://doi.org/10.1016/j.jtherbio.2008.05.004
21. Sáez-Plaza, P., Michałowski, T., Navas, M. J., Asuero, A. G., &Wybraniec, S. (2013). An Overview of the Kjeldahl Method of Nitrogen Determination. Part I. Early History, Chemistry of the Procedure, and Titrimetric Finish. Critical Reviews in Analytical Chemistry, 43(4). https://doi.org/10.1080/10408347.2012.751786
22. Shenouda, S. Y. K. (1980). Theories of protein denaturation during frozen storage of fish flesh. *Advances in Food Research*, 26(C). https://doi.org/10.1016/S0065-2628(08)60320-1
23. Singh, A. K., & Lakra, W. S. (2011). Risk and benefit assessment of alien fish species of the aquaculture and aquarium trade into India. *Reviews in Aquaculture*, 3(1). https://doi.org/10.1111/j.1753-5131.2010.01039.x
24. Tibihika, P. D., Waidbacher, H., Masembe, C., Curto, M., Sabatino, S., Alemayehu, E., Meulenbroek, P., Akoll, P., &Meimberg, H. (2018). Anthropogenic impacts on the contextual morphological diversification and adaptation of

Nile tilapia (Oreochromis niloticus, L. 1758) in East Africa. *Environmental Biology of Fishes*, 101(3). https://doi.org/10.1007/s10641-017-0704-0

25. Troell, M., Naylor, R. L., Metian, M., Beveridge, M., Tyedmers, P. H., Folke, C., Arrow, K. J., Barrett, S., Crépin, A. S., Ehrlich, P. R., Gren, Å., Kautsky, N., Levin, S. A., Nyborg, K., Österblom, H., Polasky, S., Scheffer, M., Walker, B. H., Xepapadeas, T., & De Zeeuw, A. (2014). Does aquaculture add resilience to the global food system? In Proceedings of the National Academy of Sciences of the United States of America (Vol. 111, Issue 37). https://doi.org/10.1073/pnas.1404067111
26. Worm, B., Barbier, E. B., Beaumont, N., Duffy, J. E., Folke, C., Halpern, B. S., Jackson, J. B. C., Lotze, H. K., Micheli, F., Palumbi, S. R., Sala, E., Selkoe, K. A., Stachowicz, J. J., & Watson, R. (2006). Impacts of Biodiversity Loss on Ocean Ecosystem Services\r10.1126/science.1132294. Science, 314(5800).
27. Zhang, Y., Kim, Y. H. B., Puolanne, E., & Ertbjerg, P. (2022). Role of freezing-induced myofibrillar protein denaturation in the generation of thaw loss: A review. *In Meat Science* (Vol. 190). https://doi.org/10.1016/j.meatsci.2022.108841