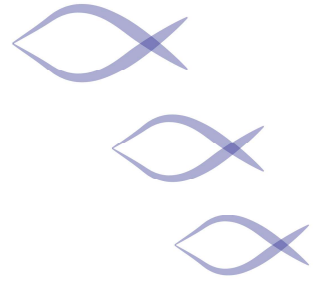


VETΛQ

VETΛQ



Melanin spots

A necessary evil in salmon production?

Lagarlíf / Aqua-Ice

Harpa, 30th of September and 1st of October 2025

Kristrún H. Kristþórsdóttir

Veterinarian

Vetaq ehf.



What is melanin and what does it do?



What is melanin and what does it do?

- Melanin is a pigment present in almost all animals and humans, except those who have a genetic condition called albinism.
- Melanin is responsible for different skin, hair and eye colors in humans and animals
 - Eumelanin – brown/black
 - Pheomelanin – red/yellow
- The most studied function of melanin is UV absorption and an anti-oxidant effect

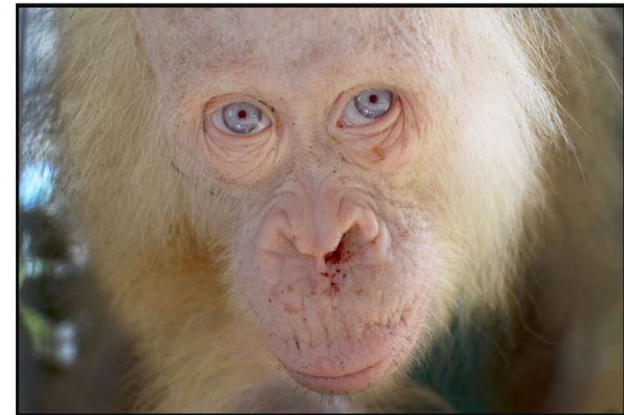


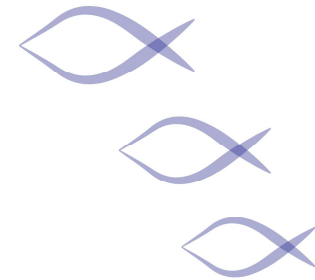
Photo credit: Reuters



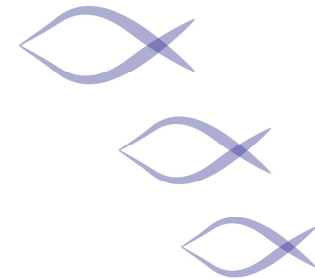
What is melanin and what does it do?

- Melanin is found in
 - Melanocytes in endothermic animals (like for example mammals)
 - Confined to the skin, eyes, inner ear and different internal organs but NOT to the immune system
 - Melanocytes and melano-macrophages in exothermic animals (like for example fish)
 - Confined to the skin AND immune system





Why does melanin appear in the muscle of salmon?



Why does melanin appear in the muscle of salmon?

The aetiology has not been fully determined

Red spots (RFCs)

Acute response, bleeding in the tissue



Black spots (MFCs)

Chronic response, immune system seeks to limit and heal the tissue damage

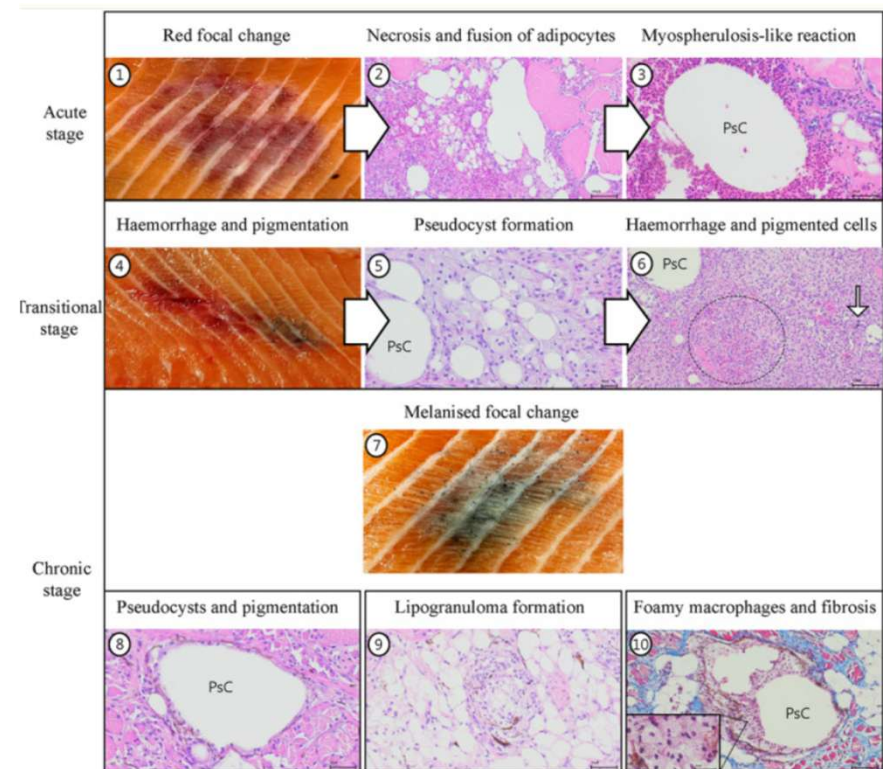


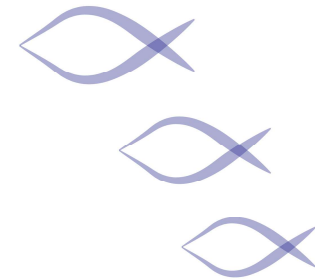
Image source: Bjørgen, Brimsholm, Asserson et al. (2024)



Why does melanin appear in the muscle of salmon?

- Melanin appears with melano-macrophages as part of a normal inflammatory response of the fish.
- Inflammatory response is triggered by trauma, infection or exposure to toxins
- PRV induces a pro-inflammatory environment that is important for the pathogenesis of the spots





Why does melanin appear in the muscle of salmon?

- Red focal changes (RFCs) and Melanized focal changes (MFCs) have not been observed in wild Atlantic salmon in nature
- Factors associated with the rearing conditions in traditional fish farms play an important role in RFC and MFC development

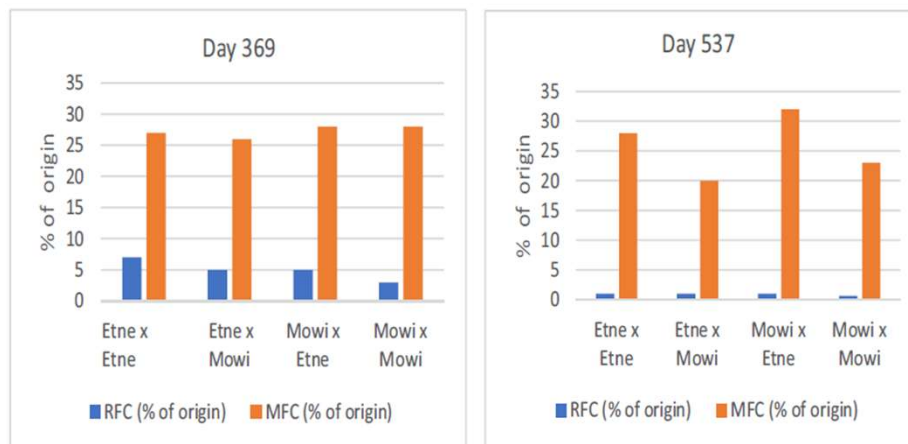
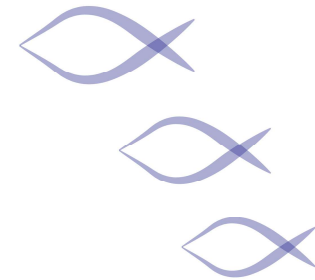


Figure source: Red and melanized focal changes in white skeletal muscle in Atlantic salmon: Comparative analysis of farmed, wild and hybrid fish reared under identical conditions, Brimsholm et al, 2023

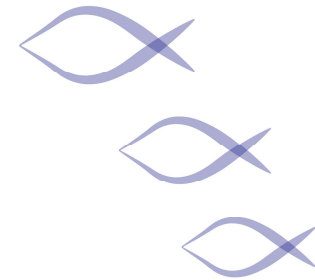
FIGURE 2 Distribution of red (RFC) and melanized (MFC) focal changes (%) between experimental groups at day 369 (a) and day 537 (b).



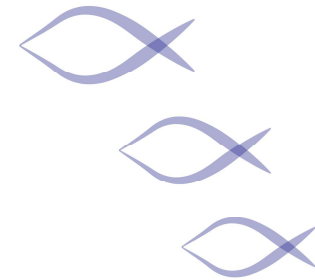
Why does melanin appear in the muscle of salmon?

- Recent research concludes that necrosis in fat cells is the most likely cause of RFCs and furthermore, MFCs.
 - Inspiration from human pathology
 - Bleeding related to fat cell necrosis
 - Placement of the spots
- New FHF research project – “Fatspot”
 - Correlation between feed, exercise and trauma, and changes in the fat tissue of the fish





What are the consequences of melanin spots
in salmon production?



What are the consequences of melanin spots in salmon production?

- Melanization of the muscle is a huge quality challenge in Norway, Chile and in Iceland
- Approximately 20% of salmon filets produced in Norway have dark spots (Mørkøre et al. 2015)
 - The prevalence shows a clear geographical variation
 - Seems to be a lower prevalence in Iceland

Tabell 1 Forekomst av mørke flekker i norsk oppdrettslaks (% av fileter).			
År	Forekomst Norge	Forekomst Nord-Norge	Forekomst Midt-Norge
2011	13 %	11 %	16 %
2012	16 %	15 %	18 %
2013	18 %	13 %	20 %
2014	19 %	15 %	23 %
2015	19 %	13 %	24 %

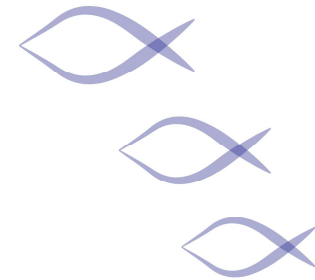
Source: Mørke flekker i laksefilet – Kunnskapsstatus og tiltak for å begrense omfanget. Mørkøre et al, 2015

What are the consequences of melanin spots in salmon production?

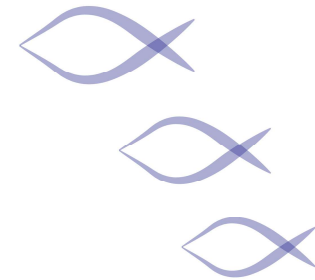


- Melanin spots must be removed at the processing plant
 - Increased labor cost
 - Lower harvest yield
- Diffuse melanization of the muscle => reduced harvesting quality or possibly not used for human consumption





How do we prevent melanin spots?



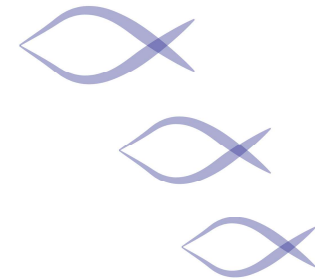
How do we prevent melanin spots?

Aetiology not fully understood – difficult to prevent completely

BUT

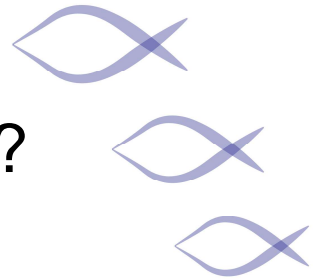
The following points could help

- Anti-inflammatory feed - High content of DHA and EPA
 - Minimize stress and handling
 - Biosecurity to reduce risk of infection



Are melanin spots a necessary evil in salmon production?

Are melanin spots a necessary evil in salmon production?



- I'd like to say no!
- Why?:
 - Wild fish in nature does not have RFCs or MFCs, but does when reared in a farming environment
 - What is it in a modern farming environment that causes the development of these spots?

Further research warranted!



Relevant research papers

Journal of Fish Diseases

WILEY

Journal of Fish Diseases

INVITED REVIEW OPEN ACCESS

Melanisation in Salmonid Skeletal Muscle: A Review

Håvard Bjørgen¹ | Espen Rimstad² | Erling Olaf Koppang¹

¹Unit of Anatomy, Faculty of Veterinary Medicine, Norwegian University of Life Sciences, Ås, Norway | ²Unit of Virology, Faculty of Veterinary Medicine, Norwegian University of Life Sciences, Ås, Norway

Received: 12 June 2023 | Revised: 16 August 2023 | Accepted: 22 August 2023

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Correspondence: Erling Olaf Koppang

Received: 3 October 2024

Funding: This work was supported by the Norwegian University of Life Sciences.

Keywords: chronic inflammation, melanisation, salmonid, skeletal muscle

Journal of Fish Diseases

WILEY

Red and melanized focal changes in white skeletal muscle in Atlantic salmon (*Salmo salar*): Comparative analysis of farmed, wild and hybrid fish reared under identical conditions

Malin Brimsholm¹ | Per Gunnar Fjelldal² | Thomas Kenneth William Fraser² | Monica Erling Olaf Koppang¹ | Håvard Bjørgen¹

¹Unit of Anatomy, Faculty of Veterinary Medicine, Norwegian University of Life Sciences, Ås, Norway | ²Unit of Virology, Faculty of Veterinary Medicine, Norwegian University of Life Sciences, Ås, Norway

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The melano-macrophage: The black leukocyte of fish immunity

Håvard Bjørgen, Erling Olaf Koppang

Unit of Anatomy, Veterinary Faculty, Norwegian University of Life Sciences (NMBU), Ås, Norway

ARTICLE INFO

Keywords: Kupffer cell, Macrophage, Melanin, Melanocyte, Melano-macrophage, Melano-macrophage centres

ABSTRACT

Melanin and the process of melanin synthesis or melanogenesis have central roles in the immune system of insects, and production of melanin-synthesizing enzymes from their haemocytes may be induced following activation through danger signals. Melanin-containing macrophage-like cells have been extensively studied in amphibians and they are also present in reptiles. In fish, melano-macrophages are especially recognized with respect to melano-macrophage centres (MNCs), hypothesized to be analogous of germinal centres in secondary lymphoid organs of mammals and some birds. Melano-macrophages are in addition present in several inflammatory conditions, in particular melanized focal changes, or black spots, in the musculature of farmed Atlantic salmon, *Salmo salar*. Melanins are complex compounds that may be divided into different forms which all have the ability to absorb and scatter light. Other functions include the quenching of free radicals and a direct effect on the immune system. According to the common view held in the pigment cell community, vertebrate melanin synthesis with melanosome formation may only occur in cells of ectodermal origin. However, abundant information suggests that also myeloid cells of ectodermic vertebrates may be classified as melanocytes. Here, we discuss these opposing views and review relevant literature. Finally, we review the current status on the research concerning melanized focal muscle changes that represent the most severe quality problem in Norwegian salmon production, but also other diseases where melano-macrophages play important roles.

International Journal of Molecular Sciences

MDPI

Eumelanin Detection in Melanized Focal Changes but Not in Red Focal Changes on Atlantic Salmon (*Salmo salar*) Fillets

Kazumasa Wakamatsu^{1,*}, Johannes M. Dijkstra², Turid Morkore³ and Shosuke Ito¹

¹ Institute for Melanin Chemistry, Fujita Health University, Toyoake 470-1192, Japan; sito@fujita-hu.ac.jp
² Center for Medical Science, Fujita Health University, Toyoake 470-1192, Japan; dijkstra@fujita-hu.ac.jp
³ Department of Animal and Aquaculture Sciences, Norwegian University of Life Sciences, NO 1432 Ås, Norway; turid.morkore@nmbu.no

PRV-1 Infected Macrophages in Melanized Focal Changes in White Muscle of Atlantic Salmon (*Salmo salar*) Correlates With a Pro-Inflammatory Environment

Muhammad Salman Malik¹, Håvard Bjørgen², Ingvald Berg Nyman¹, Øystein Wessel¹, Erling Olaf Koppang², Maria K. Dahle³ and Espen Rimstad^{1*}

¹ Section of Virology, Faculty of Veterinary Medicine, Norwegian University of Life Sciences, Ås, Norway; ² Section of

Pheomelanin in fish?

Verena A. Kottler¹, Axel Künstner^{1,2,3} and Manfred Schartl^{4,5}

¹ Department of Molecular Biology, Max Planck Institute for Developmental Biology, Tübingen, Germany ² Guest Group Evolutionary Genomics, Max Planck Institute for Evolutionary Biology, Plön, Germany ³ Lübeck Institute of Experimental Dermatology, University of Lübeck, Lübeck, Germany ⁴ Department of Physiological Chemistry, Biocenter, University of Würzburg, Würzburg, Germany ⁵ Comprehensive Cancer Center Mainfranken, University Clinic Würzburg, Würzburg, Germany

CORRESPONDENCE: Verena A. Kottler, e-mail: vkottler@u.washington.edu

doi: 10.1111/pcmr.12359

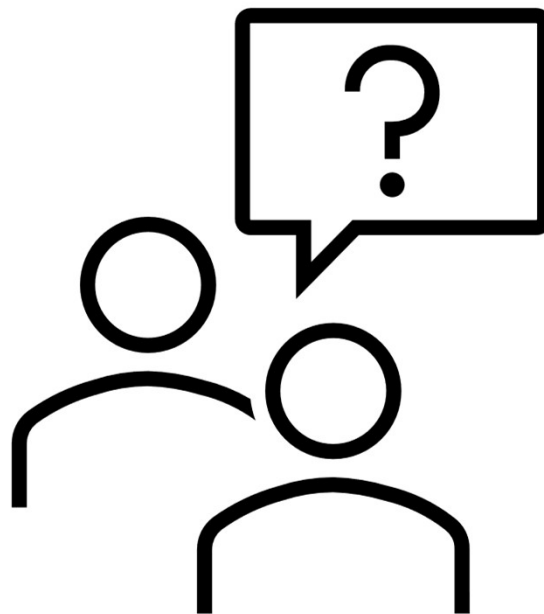
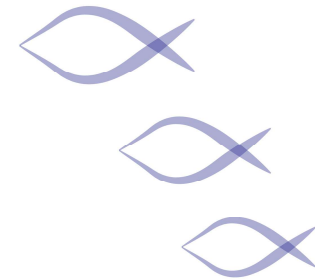


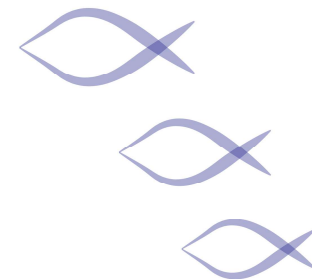
Thank you!



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Questions?





Wanna talk fish health?



Kristrún H. Kristþórsdóttir

+354 698-2716

kistrun@vetaq.is

