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Published in:
10th Nordic Conference on Plasma Spectrochemistry

Publication date:
2022

Document Version
Publisher's PDF, also known as Version of record

(P-31)

FEED-TO-FISH TRANSFER OF ARSENIC AND ARSENIC SPECIES IN ATLANTIC SALMON FED ON DIETS CONTAINING NORWEGIAN FARMED BLUE MUSSEL AND KELP

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Norwegian aquaculture aims to significantly reduce the environmental and climate footprints of feed production. Consequently, low trophic marine resources such as blue mussels and kelp farmed locally are potential candidates to be used as ingredients in salmon feed. In this context, mapping of risks associated with the use of novel feed ingredients, as well as understanding the transfer of undesirables from feed-to-fish, is of high importance. Moreover, there is a current discussion on establishing maximum limits for inorganic arsenic in different foodstuffs in the European Union. Thus, it is important to obtain data on concentrations of arsenic and arsenic species in farmed salmon when being fed novel low trophic marine feed resources such as blue mussel and kelp.

The objectives of this work were: (i) to describe concentrations of total arsenic and its different chemical species present in novel salmon feeds containing blue mussel and kelp, and (ii) to evaluate whether the feed-to-fish transfer depends on the arsenic species. Atlantic salmon were fed experimental diets for 70 days. Four diets were prepared containing up to 4% fermented kelp, and four diets were prepared using up to 11% blue mussel silage or 12 % blue mussel meal. Concentrations of arsenic and arsenic species in feeds, faeces, liver and fillet of Atlantic salmon were determined by inductively coupled plasma mass spectrometry (ICP-MS) and high-performance liquid chromatography coupled to ICP-MS (HPLC-ICP-MS), respectively. The apparent availability (%) was determined using a ratio between the concentration of arsenic in diet and in faeces and the concentration of an inert marker (i.e. yttrium oxide) in diet and faeces. The retention (%) is expressed as the ratio of the difference between the final and initial arsenic concentrations in liver/fillet, and the concentration of arsenic in diet and feed intake.

The use of kelp or blue mussel-based feed ingredients increased the levels of total arsenic but maximum limits as defined in Directive 2002/32 EC and amendments were not exceed. The concentrations found in the experimental feeds ranged from 3.4 mg/kg to 4.6 mg/kg. Arsenobetaine, inorganic arsenic and one arsenosugar (AsSug328) were the most abundant arsenic species in the feeds. Arsenic speciation in the feed varied based on the ingredient, with arsenobetaine dominating in blue mussel-based feeds, while arsenosugars were abundant in kelp-included feed. The apparent availability of total arsenic ranged from 67% to 83%, but retention in fillet only ranged from 2% to 22% and in liver from 0.3% to 0.6%. For inorganic arsenic, the apparent availability ranged from 54% to 69%, but inorganic arsenic was not retained in fillet nor liver as no detectable levels were found. Despite relatively high apparent availability of total arsenic and inorganic arsenic, the retained concentrations of arsenic did not reflect the same trend.

This study shows that speciation analysis provides valuable information of the feed-to-fish transfer of arsenic.