Fish waste – a resource

The amount of farmed Atlantic salmon in Norway was 1.27 10^6 tons in 2014. This results in 0.34 10^6 tons of waste (residual raw material). In addition, even more waste is produced from pelagic catch, which is less available given the market price.

Some of this waste is currently used mainly for animal feed material, while oil, protein and protein hydrolyzates are also used. The overall value of this waste is low and obviously its value could be increased if useful and complex biomolecules with specific targets could be found.

The anticoagulant (”bloodthinner”) heparin has been used in the clinic since the 1930´s and the worldwide annual amount used is around 100 tons at the value of 7 10^9 USD.

Chondroitin has been suggested to be a therapeutic agent in a number of diseases such as inflammatory bowel diseases, atherosclerosis, Parkinson's and Alzheimer's diseases, multiple sclerosis, amyotrophic lateral sclerosis, rheumatoid arthritis and systemic lupus erythematosus. Chondroitin, that helps cartilage retain water, has been sold for some years as food supplement with the claims to reverse osteoarthritis. However, a large scale test by the US National Institute of Health was unable the prove any relief for patients with knee osteoarthritis. Both heparin and chondroitin are complex carbohydrates that interact with a great number of proteins as evidenced from their multiple targets. The conflicting reports on their actions could, in part, be due to the heterogeneity of these compounds. Heparin has been attributed possible roles as anti-cancer and anti-inflammatory agents and some non-anticoagulant forms of heparin have been shown to retain anti-inflammatory activity. In fact, heparin/heparan sulfate has been shown to react with 450 different human proteins. There have been claims that heparin is not present in fish, but it is now evident that heparin with similar composition to that in mammal species is found in zebra fish and Atlantic salmon (see references within the referred article). The specific anticoagulant activity in Atlantic salmon heparin is in the same range as heparins used in the clinic.

The present publication shows that heparin and chondroitin from the intestines and gills contain disaccharides, with some exceptions, similar to those described in other species. The heparin trisulfated disaccharide crucial for high activity heparin is found in Atlantic salmon and in zebra fish, although in apparent less amounts in Atlantic salmon heparin. The different amounts of heparin reported could reflect real differences in heparin in fish or some difficulties in purifying heparin from fish (which might sound fishy for experts in mammal heparin). The experiences with fish heparin suggest the latter possibility. A heparin amount of 100 tons is just a small fraction of the raw material available, but developing an economically feasible and high activity yielding process could be a challenge.

A relatively rare heparin disaccharide, that was not found in porcine or zebrafish heparin, appeared in the highest amounts in both intestine and gills heparin.

A chondroitin disaccharide that was suggested to have an essential role in the development and differentiation in zebrafish was also detected in Atlantic salmon, as well as disulfated disaccharides that has been suggested as useful markers for marine origin of chondroitin.

Obviously, these compounds are of great importance for understanding biology and for potential use. Their complexity and heterogeneity necessitates further purification and analysis.

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