Authentication of organic fish products using $d^{13}C$ and $d^{15}N$ in fillet

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Aquaculture is of increasing importance for the production of edible fish because of dwindling natural resources. In particular organic aquaculture shows considerable growth rates. With respect to consumer protection the potential risk for conventional products being wrongly labelled as organic must be encountered by additional instruments for a complete traceability of edible fish from organic aquaculture. In addition to controls along the process chain these should be applicable on the retail level by the trade or food monitoring authorities. Therefore, the presented work evaluated the applicability of stable isotope analysis to the discrimination between organically and conventionally farmed fish as well as wildly caught fish of selected species. In particular, C and N isotopes were utilized, being known to vary in marine species subject to food sources.

In a BÖLN funded project (German Federal Programme on Organic Farming and Sustainable Agriculture, project no. 08OE026) 250 samples of brown trout, iridescent shark, gilthead sea bream and shrimps originating from different farms or sea areas were collected over a period of two years. Moreover, 80 samples of processed fish (smoked brown trout and graved or smoked salmon) were obtained. After extraction of lipids from the fillet, defatted dry matter (DDM) and lipids (LIP) were separately subjected to stable carbon isotope ($d^{13}C$) analysis. In addition, stable nitrogen isotopes ($d^{15}N$) were analyzed in DDM. Analyses were performed using a Thermo Scientific EA-IRMS system (Flash EA 1112, ConFlo III, DELTAplus XL).

Brown trout, iridescent shark and salmon from organic aquaculture showed higher $d^{15}N$ than the respective conventionally farmed fish, which allowed to largely identify the different husbandry. Whereas differentiation by $d^{15}N$ was complete for iridescent shark and salmon, the authentication of organic brown trout could be improved by combining $d^{15}N$ and $d^{13}C$ of DDM. However, gilthead sea bream and shrimps from organic aquaculture could not be distinguished from conventional products even by using both $d^{15}N$ and $d^{13}C$ data.

Wildly caught individuals of gilthead sea bream always had higher $d^{15}N$ than any farmed ones. Although wild shrimps showed a trend to higher $d^{15}N$ compared with organically farmed ones, these could only be differentiated completely by additionally considering $D\ ^{13}C_{DDM\text{-}LIP}$. Wild and conventionally farmed shrimps did not have characteristic differences in $d^{15}N$ and $d^{13}C$. Wild salmon could be distinguished from conventional by $d^{15}N$ and from organic by $d^{13}C_{LIP}$. Thus, the combination of $d^{15}N$ and $d^{13}C_{LIP}$ allowed for the simultaneous identification and differentiation of all three origins. Samples of wild brown trout or iridescent shark were not included in this work.

The observed environment-related variation in delta values within one species results from differences in feed composition and possibly from deviating growth rates as well. Because natural processes often lead to the enrichment of heavier isotopes along the food chain, the food chain level of animal prey and the percentage of plant versus animal material in the feed are important factors determining the isotopic signature of fish. Hence, the authentication of organic fish or fish products comprising brown trout, iridescent shark and salmon could be accomplished by analysis of $d^{15}N$ and $d^{13}C$ in fillet matter. The investigated kinds of fish processing did not interfere with the isotopic differentiation. Organic authentication of other fish species might be improved by combining stable isotope data with fatty acid or carotenoid contents.

Conference Programme & Book of Abstracts

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