Success Story
COMET

FFoQSI
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Determination of the provenance of sturgeon caviar

Summary – A method to identify the authenticity and provenance of sturgeon caviar was developed based on a multi chemical fingerprint which allows the tracing of a single egg back to the aquaculture in which the caviar was harvested. The method provides a substantial milestone in the 'fight against fraud by analytical methods'.

Caviar the "Black Gold"

Sturgeon caviar, the processed unfertilized eggs (roe) of *Acipenseriformes* species, is one of the most expensive food commodities in the world.

As aquaculture production of caviar continues to develop, there is a decline in the population of wild sturgeon, mainly due to overuse, poaching, illegal trade and destruction of natural habitats. Moreover, caviar smuggling using local farms as front to e. g. avoid paying the local taxes and duties on the import of the caviar has been documented to take place at a large and global scale. As a result, the trade in sturgeon caviar was regulated by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). These measures include legal caviar identification using a single labelling system. However, current measures to control compliance with labelling requirements are based primarily on low-level administrative controls. Therefore, analytical tools are needed to verify the authenticity and origin of sturgeon caviar clearly and forgery-proof. Ultimately, this measure serves to promote legal caviar trading and sustainable aquaculture.

One of the most promising approaches to determining origin is the analysis of the elemental and isotopic composition of caviar. This intrinsic "chemical fingerprint" is taken up by the fish primarily via water and fish feed and is, therefore, difficult to counterfeit. The elemental and isotopic composition of caviar may then be compared to fish farming water. If the "fingerprints" match, the correct labelling of the examined caviar can be confirmed.

Analytical methods to fight food fraud

The project aimed at the identification of the major chemical discriminators of fish caviar of different origin. In a comprehensive study, water, fish feed, salt, raw and salted caviar from seven sturgeon fish farms (one in Austria, one in Germany, four in Italy and one in Iran) were investigated. The samples were analysed for their elemental and isotopic composition of strontium ($^{87}Sr/^{86}Sr$) using inductively-coupled

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plasma mass spectrometry (ICP-MS). This technique allows precise measurements of the elemental and isotopic composition at ultra-trace levels (down to ng g^{-1}).

The major breakthrough was the identification of the major parameters, which led to a 100 % discrimination of the investigated fish farms. Our results showed that sturgeon caviar of different origin could be best characterized via the $^{87}Sr/^{86}Sr$ isotopic as well as the Fe/Ca, Mg/Ca, K/Ca, Co/Ca, Na, Mg, Mn, Cu, As, Rb and Mo elemental composition of water and feed. Therefore, these chemical parameters represented site specific environmental markers. Since multiple isotopic and elemental markers could be obtained, the chemical fingerprint has the potential to provide a forgery-proof intrinsic information to identify the provenance of caviar.

Fig. 1: Analysis and data interpretation (from left: A. Tchaikovsky, T. Prohaska, A. Zitek, J. Irrgeher) © VIRIS Lab, BOKU

An additional aspect to be considered when dealing with caviar is, that commercially available caviar is usually salted. Salting was found to have a significant effect on the $^{87}Sr/^{86}Sr$, Fe, Mn and As composition of caviar.

But also salted caviar could be discriminated amongst the individual fish farms, even though the direct link to the geographically typical parameters of e. g. the water were masked. In order to retrieve the original information of the fish farm, provided mainly by the water and to a lesser extent by the feed, a mathematical method for the correction of the influence of salt on the $^{87}Sr/^{86}Sr$ isotopic composition was developed.

Impact and effects

The developed method provides an unambiguous tool to identify the authenticity and geographical origin of caviar. The method can be refined by using light stable isotopes (C, O, H, N, S) in combination.

Abb. 2: Sturgeon caviar from aquaculture helps to protect the species © A. Zitek, FFoQSI

A logical next step to fight illegal trade and support sustainable aquaculture and species protection is the development of an international caviar database in collaboration with different institutions and organizations.

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