

Breeders Talk Blue: The Potential and Opportunities of Gene Editing in Aquaculture

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The joint webinar of EATiP, EFFAB & FABRE TP, around the potential and opportunities of Gene Editing in Aquaculture was opened by David Basset and Ana Granados, Secretary General of EATiP and FABRE TP. They welcomed the participants and thanked all for joining. Further, they acknowledge the multi-stakeholder approach to promoting research of both Technology platforms and their fruitful collaboration during the year on presenting together this extremely important topic in the Aquaculture sector.

Currently, gene editing in aquaculture is showing the fastest development in research, and the applications of such techniques are relevant to many aspects of the sector as shown through the webinar.

Opening talks

Gene editing in Europe – a policy status, by Frank Swartenbroux | EC DG SANTE Biotechnology unit

Frank Swartenbroux, from the European Commission opened the session by providing an update on the policy status of Gene Editing in Europe. Frank explained the context of the Farm to Fork Strategy and the overall objective of improving the sustainability of our food system.

Within the scope of the Council request (EU) 2019/1904, a profound in-house study was done by DG SANTE on the state of play of implementation of EU GMO legislation for new breeding techniques (NBTs). The EC considers that NBTs can contribute to achieving the goals of the Green Deal and Farm to Fork Strategy. In the study it was also clear that NBTs applications should not undermine other aspects of sustainable food production.

After the publication of the study, the EC put forward a policy initiative for legislation for plants produced by targeted mutagenesis and cisgenesis. Frank noted that the study is now 1-year old and that much progress has been made in the aquaculture field, to their surprise.

Then Frank proceeded to present the scope and objectives of the policy initiative, followed by the policy elements to be considered. Throughout 2022 the EC will be conducting the Impact Assessment for the policy initiative in plants, that will count with a Public Consultation and will lead to a possible legal proposal by 2023.

Gene editing - what is it about? Diego Robledo | Roslin Institute

Diego Robledo, from the Roslin Institute presented the basics of gene editing and its applications. Diego explained that gene editing, is nothing more than targeted changes to the DNA of a cell, with targeted being the key word.

Diego then spoke about the origin of CRISPR-Cas systems and how it works and how it lead to CRISPR-Cas genome editing. CRISPR-Cas9 is a system repurposed by Jennifer Doudna and Emmanuelle Charpentier to target specific DNA sequences and genes.

Throughout the presentation, it was highlighted the potential of genome editing to improve any trait without being limited to existing genetic variations. Also pointing to the challenges of genome editing, such as: finding the right piece of DNA, off targets (that can be controlled and assessed), and interactions with populations and genetic diversity.

Diego finished his presentation pointing how important is communication to citizens and the some key messages that we can all use to talk with the general public ; Gene Editing has a huge potential to improve animal health and welfare and reduce environmental impact of animal farming. It can also help to reduce antibiotic use and improve human health. He also emphasized the fact that impact on wild populations can fully be avoided and repeated that those targeted small changes can also occurred in the nature.

Presentations

A perspective on potential uses of GE in salmon breeding and production, by Anna Wargelius | Institute of Marine Research

Anna Wargelius, from the Institute of Marine Research (IMR) presented a perspective on the potential uses of gene editing in salmon breeding and production. She emphasized that it's not only about the use of GE but also very important to understand the biology of the fish. Anna presented the main sustainability challenges in aquaculture they are currently working on : diseases, local feed adapted to the fish, genetic introgression and welfare. At IMR they are trying to improve them through gene editing which in salmon proves to be a very potent and efficient technology.

Anna explained one of the IMR Project's in which they have managed to provide sterility to salmon and replace triploids ; avoiding animal welfare issues related. Investigations have been done targeting the welfare problems. The limit is to implement it in the field and their research has been focusing on this aspect.

Disease resistance, by Ross Houston | Benchmark Genetics

Ross Houston, from Benchmark Genetics presented on genome editing for disease resistance in aquaculture. Ross started his presentation by providing an overview on the recent domestication of aquaculture species Since it is a recent and ongoing task, there is a huge potential for genetic improvement in many species. Ross also noted that genetics plays a key part in tackling sustainability challenges.

Currently, diseases represent a persistent threat to aquaculture and breeding and genome editing technologies hold a particular promise to solve it. Ross explained how gene editing is a disruptive technology for aquaculture breeding and methods are becoming established and showed some examples. Ross then went into detail on three categories of applications that require distinct research; Gene editing for a major QTL, introgression of desirable alleles from other strains and creating novo alleles with favorable effects on the trait.

Important to note, that gene editing is a possible tool in the toolbox of aqua breeders, but not a replacement. Implementation is a big challenge, since current methods are laborious, inefficient and result in high mosaic animals.

Salmon lice resistance, by Tone-Kari Knutsdatter Østbye | Nofima

Tone-Kari Knutsdatter Østbye, from Nofima, presented the work of the project for sea lice resistance using gene editing in salmon. Sea lice is a big problem in aquaculture, it causes a large economical loss, decreases welfare and there are no control measures that are effective. Genetic variation is important and it allows to include sea lice resistance in current breeding programs. However, this is not enough to reduce drastically the incidence of sea lice; Atlantic salmon remains more susceptible whilst other types species are highly resistant. Kari also explained the different mechanisms of resistance in highly susceptible salmon. Through that they concluded that if genes and mechanisms involved in sea lice resistance are identified, then gene editing can be used to test and prove that the genes have an effect and potential for creating resistance in Atlantic salmon can be evaluated.

Through a new project, Tone-Kari and partners are looking to increase the knowledge on genes and mechanisms affecting lice resistance in Atlantic salmon. Then to apply the knowledge to achieve high or full resistance in Atlantic salmon to reduce the need for delousing. So far, they performed a sea lice challenge test to which Tone-Kari explained the process and early results. Interaction between sea lice and fish and the gene mechanisms involved in resistance have been investigated in the project. A model to evaluate the risk that sea lice overcome the genetic resistance of fish is also part of the project. The expected results are the identification of new strategies to deal with sea lice resistance, either using gene editing or breeding or a combination of both.

Gene editing approaches, by Alan Tinch | Center of Aquaculture Technologies

Alan Tinch, from the Center of Aquaculture Technologies (CAT) dived into when and why will we see gene editing in aquaculture. For CAT, gene editing is possible for the majority of aquaculture species and has a great potential, and legislation will become more adapted to the technique and accessible for breeding companies in an increasing number of countries. Sterility will be a prerequisite to effective use of gene editing and will be incorporated by breeders and producers to meet the needs and expectations of producers and consumers. CAT sees gene editing as the next revolution in breeding, since it will allow to improve traits that were not possible to change before, such as: sex, fertility, disease resistance and economic sustainability.

Alan asserted that gene editing is not a tool on its own, it's a complement to the breeding program, one more tool on the toolbox with unlocked potentials. Alan then went into details of where and when will gene editing for aquaculture could be developed.

Webinar conclusion

Gene Editing in Aquaculture is a fast moving area, but we must remember and be reassured that there are safeguards for the use of technology and that principles and ethics are not sacrificed. *“Evolution is a work in progress, are you taking part?”*

Nonetheless, it's essential to remember that gene editing as the potential to become a tool for breeders and farmers, but it is not the only answer or the single solution.

Audience :

The audience of the webinar was 50% from research institutes and universities. The private sector represented 34%. And the rest of the audience was distributed between NGOs and policy makers.

The motivation to join the webinar was around half of the attendance working in Gene Editing in Aquaculture but also in other sectors and the second half not directly involved but having interest in the topic.

Questions to the audience :

A couple of questions were addressed to the audience.

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What target traits would you consider to be of the highest priority for aquaculture in commercially-applied gene editing?

