FELLOWSHIP SUMMARY REPORTS

Cover page

Prof. Maurizio Selva, Department of Molecular Sciences and Nanosystems, Ca' Foscari University of Venezia, Italy

Sustainable Valorization of Non-Edible Residues of the Aquaculture and Fish Processing Industries: learning from the Australian Standard

Theme I, MANAGING NATURAL CAPITAL FOR THE FUTURE, subset *Aquaculture and Fisheries*

Hosted by the School of Chemistry at the University of Sydney, NSW, Australia

Host collaborator: Prof. Thomas Maschmeyer

15 weeks during April 2019 – July 2019

I consent to my Report being posted on the Co-operative Research Programme's website

1. **What were the objectives of the research project?**

The three major objectives of the proposal were:

i) A critical assessment of the current extractive protocols of fish wastes, classified by the type of discards, in order to support the investigation of innovative chemical sequences to valorise extracts.

ii) The investigation of functional/chemical modification of low-grade fish oils and the market perspective for fish-waste based fillers in composite materials.

iii) Analysis of technologies for fish residue biorefining and valorization of products

1a. **Why is the research project important?**

The project addresses Theme I, Managing Natural Capital for the Future**,** identified by the Co-operative Research Programme (CRP), specifically in the subset *Aquaculture and Fisheries* aimed at a sustainable aquaculture and fishery practices. The impressive growth in the World per capita fish consumption witnesses the role of fisheries and aquaculture for food security and nutrition, but it is also raising a tremendous concern on the amount of wastes generated by fish processing. On the other hand, fish bio-wastes represent a resource of an extraordinary chemical richness including oils, amino acids and bioactive peptides, collagen, chitin, gelatin, pigments, etc., which is certainly worth valorising. Many processes and technologies have been reported in the past decade or so, for the upgrading of such residues; though, there is still way to go for integrating this already available knowhow in the current practice for processing fish. The fellowship research proposal (FRP) has been aimed to providing an insightful definition of the waste-to-wealth concept through a close inspection of protocols to extract and upgrade of fish residues to achieve high added-value products with a potential in the sectors of nutraceuticals, cosmetics, and advanced materials.

2. **Were the objectives of the fellowship achieved? Or are they on the way to being achieved?**

Objectives i) and iii) were fully achieved through an extensive analysis of the current literature. A review article including ca 350 references with substantial sections devoted to technologies for the biorefining of either the organic and the inorganic components of the fish wastes, was prepared. The survey explored the upgrading of fish discards into high-added value fish oils and small peptides (fish hydrolysate) and the fabrication of innovative materials from fish-derived collagen, chitin, chitosan and hydroxyapatite. The paper will be submitted for publication in the next few weeks.

Moreover, a semi-structured interview to Prof. Colin Barrow at the Deakin University and a visit at Mantzaris Fisheries in Geelong (Victoria, Australia) were of help to understand strategies for fish biorefining and to compare major techno-economical drivers/interests for the australian companies operating in the sector.

As far as objective ii), the analysis of the literature carried out during the first three weeks of the project prompted to a recalibration of the originally planned experimental activities. Such changes were anticipated in the research proposal that claimed a certain degree of flexibility in timing and content of activities depending on the results in the making. The variations were agreed upon between the fellowship holder and the host collaborator at the University of Sydney, to improve either the alignment of the work with major current trends in the sector and the design of experiments in the framework of preparation methodologies with lower carbon footprint. In particular, the implementation of an eco-friendly protocol for of the alkylation of chitosan derived from fish wastes, was investigated rather than the chemical modification of fish oil and the study of fillers based on fish waste. Indeed, alkylated (methylated) chitosan is one of the most

promising and attractive bio-polymer for a variety of applications spanning from drug and gene delivery to heavy metal extraction, tissue engineering and development of anti-microbial and anti-tumor agents. A research article was prepared on this subject and it is currently under evaluation for publication.

3. **What were the major achievements of the fellowship? (up to three)**

i) A well-rounded assessment of current methods and technologies for the upgrading of fish biowastes
ii) An experimental activity finalized at the chemical modification of fish-derived chitosan via its methylation with a non-toxic reagent (dimethyl carbonate)
iii) Consolidation of the collaboration between Ca' Foscari University of Venice and the School of Chemistry at the University of Sydney, and establishment of new contacts with the School of Life & Env. Sciences at Deakin University (Victoria, Australia)

4. **Will there be any follow-up work?**

o Is a publication envisaged? Will this be in a journal or a publication? When will it appear?
Yes, two papers have been/are in preparation in the form of a review and a research article, respectively, co-authored with Prof. Maschmeyer (the host collaborator) at the University of Sydney. Both works will be submitted in top-ranking scientific journals in the chemical/environmental sectors. The research article is currently under evaluation, while the review paper will be plausibly submitted by late Summer 2019.

o Is your fellowship likely to be the start of collaboration between your home institution and your host?
As mentioned in the research proposal, a long-standing collaboration exists between the group led by me (fellowship holder) at the Ca' Foscari University and the one directed by Thomas Maschmeyer. However, the Fellowship has been a remarkable opportunity to strengthen the mutual scientific esteem and friendship between the groups, with the perspective to continue keeping our cooperation active in the future.

o Is your research likely to result in protected intellectual property, novel products or processes?
No results in PIP are expected in the short term. However, the study performed during the OECD fellowship will most plausibly provide a benchmark for future projects to funding research activities at different levels (Regional, National, and European). In this respect, novel products and processes might be developed in the medium term (2-4 years).

5. **How might the results of your research project be important for helping develop regional, national or international agro-food, fisheries or forestry policies and, or practices, or be beneficial for society?**
Please express this in terms of environmental/food security/food safety/economic/health (human and livestock and plant) benefits, etc.
The activity carried out during the fellowship, particularly the above-mentioned review article will be of general interest for the operators of the sector, both from Academia and Industry, as an update on the knowhow, technologies and practices available for a sustainable fish waste processing. As a result/ consequence, flexible biorefining approaches could be identified considering variations of productions, territorial needs, and already available infrastructures of different coastal and marine areas. This strategy is expected to be of help for the coastal regions of the Northern Adriatic Basin (the area familiar to the Fellowship holder) where the upgrading of fish waste is still underdeveloped, but it may be extended to other coastal environments in which fishery and aquaculture are the basis of the local economy. Overall, this

activity may offer a complementary tool to inform future policy decisions (from regional levels up) on approaches to improve circular economy, blue growth, and sustainable use of marine biomass.

6. **How was this research relevant to:**

o The objectives of the CRP?

The research of the fellowship has been aimed to investigate sustainable strategies for fish biorefining where the processing of marine biomass is integrated with the valorization of the related wastes. This study contributed to the CPR objectives in the field of the management of fishery and aquaculture.

o The CRP research theme?

This fellowship was mainly focused on theme I of the CRP, MANAGING NATURAL CAPITAL FOR THE FUTURE, especially the subset Aquaculture and Fisheries, the objectives of which are addressed to reduce pressure on marine and fresh water ecosystems recognized among the most important sources of food and bio-energy products. Within the paradigm of the circular economy, the used approach has been oriented to explore and highlight the multiple benefits deriving not only by the achievement of high-added value products and materials - of interest for the market - from fish discards, but also from the promotion of more efficient activities in the field of aquaculture and fisheries, able to lower the impact of the anthropic exploitation of marine resources and to help preserving coastal environments.

7. **Satisfaction**

o Did your fellowship conform to your expectations?

Yes. Within the limited funds granted, the fellowship offered a great opportunity to consolidate the collaboration with the hosting Institution and to devise further programs both with the host collaborator and his colleagues at the University of Sydney.

o Will the OECD Co-operative Research Programme fellowship increase directly or indirectly your career opportunities? Please specify.

An (indirect) advantage coming from results gathered during the fellowship is the perspective of submitting proposals for funding future research programs and collaborations in the investigated field

o Did you encounter any practical problems?

No. Logistic at the University Campus was comfortable and the host hospitality at the school of chemistry was excellent.

o Please suggest any improvements in the Fellowship Programme.

Compared to both the Australian and the European standard, the cost of living in Sydney is rather high. This is probably a good reason to review and improve the amount of the given grant by taking into accounts geographical differences.

Moreover, the evaluation model of proposals can be improved by providing fellowship holders with details on the assessment of their projects. It would be helpful to know comments including points of strength and weakness of proposals, of the panel of experts who evaluated them.

8. **Advertising the Co-operative Research Programme**

o How did you learn about the Co-operative Research Programme?

From the research division office of my University

o What would you suggest to make it more “visible”?

Past fellowship holders are probably the most indicated persons to advertise the CRP. I believe OECD should explore tools to incentivize these people to promote the CRP by either conferences and meetings.

o Are there any issues you would like to record?

None.