Traceability and Quality Monitoring throughout the Fish Value Chain

D2.3 Pilot Design and Piloting plan (v1.0)

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ACRONYMS LIST

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EB	Executive Board
MS	Monitoring Secretariat
PB	Project Board
PCO	Project Coordinator
WPL	Work Package Leader
TMF	TraceMyFish

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EXECUTIVE SUMMARY

The objective of WP2 "Tracking hazards and potential measures" is define and outline the piloting settings so as to track the potential hazards across the Bluebio value chain affecting food quality and safety along three crucial value chains in Europe, and more precisely: 1) the Atlantic salmon value chain, 2) the Atlantic whitefish value chain, and 3) the Mediterranean seabream/seabass value chain. In addition to tracking potential hazards, WP2 is targeting to map the critical parameters affecting the quality and also the safety, by employing non-invasive sensors (VideometerLab and VideometerLite), laboratory respectively portable multispectral imaging instruments; meaning the use of non-destructive measures to be included in the iFish Management System (iFMS) for hazard control, prevention and alerting mechanism to be developed within the project. In this report, we present the identified variables, as they stem out from the mapping of the needs of the related stakeholders in tandem with the potential/envisioned hazards inherent along the three value chains considered in the project; a work performed in Task 2.1 (please refer to D2.1 for more details). So, using the output from Task2.1 we are able to define and select the appropriate parameters, measures, and sensor strategies to be implemented into the first iFMS pilot. Since the selected, aforementioned, three value chains have their specific challenges, the three responsible research partners: NTNU, AUA, and UoI have focused their efforts on the value chain of Atlantic salmon, Gilthead seabream/European seabass, and Atlantic whitefish, respectively. This deliverable consists the first version of the pilots that will be performed during the project, mainly focusing to the feasibility of the proposed scheme of tracking and quality assessment along the food chain with the employed non-invasive instrument under real or close to real conditions. Additionally, the aim also is to populate a reference lake of appropriate datasets for model development. Models that will be able to predict, identify and report quality and tracking information along the food, fish "journey" from the initial production to the consumers' hands.

1 INTRODUCTION

Herein, we present the first version of the deliverables for Task 2.2., dedicated to the design of the overall pilot schemes that will be applied across the project, in terms of the three use cases considered. In this first version we present the outcomes of the mapping of stakeholders needs and expectations (also in close collaboration and respectful to Task 2.1) onto a roadmap for the pilots for the three use cases, i.e. the Atlantic salmon, the Gilthead seabream/European seabass, and the Atlantic whitefish, respectively. To this end, the research partners, namely UoI, NTNU and AUA along with the industrial partners identified the related variables for the continuous non-invasive monitoring of the products and processed products assumed in the project (please refer to D2.1). The three use cases are harmonised under a common pilot design since apart from the raw first material (type of fish), the rest of the value chain remains more or less the same. Briefly, the pilot variables that need to be defined correspond to the time and place of performing the data acquisition, where time and place refer to the different/several sites along the value chain; i.e. the production, transportation, food processing and storage in between the former ones. The definition of those variables is very critical in order to enable a sufficient and efficient, in terms of data completeness and coverage of the whole value chain.

Additionally, specific technological, sensor related issues and variables are identified, in a way that the applicability of the sensor along the value chain is ensured. This enables the downstream effective design of the cloud services that will be provided to the end user of the TraceMyFish platform/solution. As before regarding the aforementioned variables (in the monitoring phase), the definition of the technical variables for the pilots are mandatory for the design of a system suitable for efficient product monitoring and tracing, including the requirements in terms of accessibility, usability and acquaintance to the use technologies from the specific persons acquiring and inferring the data. In this first version of the pilots design and variable identification along the food chain we designed the corresponding pilot studies and particularly their design and specifications (concerning data acquisition calibration), while the second will serve as an adaptation and finalisation of the pilots towards the acquisition of the evaluation and demonstration data for the TraceMyFish platform.

2 VARIABLES IDENTIFICATION ALONG THE FOOD CHAIN

Herein, we present our initial mapping of the critical parameters that affect, have profound impact on the quality and safety of the products along the fish value chain, as it will be followed by the corresponding three (3) pilots; i.e., 1) the Atlantic salmon value chain, 2) the Atlantic whitefish value chain, and 3) the Mediterranean seabream/seabass value chain. To this end, we outline the identified non-destructive measures to be included in the iFish Management System (iFMS) for hazard control, detection, and prevention, as planned to be developed and applied downstream in the project. We should mention that the below mentioned variables has been recognised during Task 2.1 and the accompanying deliverable D2.1, where the corresponding hazards and stakeholders' needs are mapped, for each pilot case independently. The identified variables will be employed and used towards the continuous non-invasive monitoring of the products as they assumed in the project.

The pilot variables that need to be defined correspond to the time and place of data acquisition, where time and place are referring to the different sites of the value chain (i.e. production, transportation, food processing and storage). In addition, any emerging hazards and unwanted incidents, e.g. changes in temperature while transportation or at storage, capable of causing adverse effects in the final or intermediate products across the food chain are identified and taken under consideration. Finally, hazard characterisation, where the qualitative and/or quantitative evaluation of the nature of the adverse effects of contaminants (e.g., pathogenic bacteria, parasites, chemical contaminants, etc.) present in the above mentioned products (raw, processed, in/at storage facilities) along the value chain, are undertaken.

2.1 SENSOR EMPLOYED THROUGHOUT THE PILOTS DESCRIPTION

The Videometer Spectral Imaging Technology is one very promising and already validated efficiency in prediction of quality and safety technologies in the food domain. It is **non-destructive** allowing the detection of hazards and quality related issues as well as a product's chemical and physical structure. Videometer spectral imaging instruments measures more than 12 million individual spectra on a food sample within a few seconds (7-8seconds), in a structure of a data cube, several spectral planes (7 different wavelengths) where each plane reflects a monochromatic image at a specific wavelength. Every pixel in the image is a spectrum covering UV, visual color, and NIR ranges, including a fluorescence option, and of areas down to 65×65 μm. The analytical power of the technology offers a unique potential for fast characterisation of food integrity in terms of color, surface chemistry, texture, shape, and size without touching the sample and with little or no sample preparation. In the *TraceMyFish* project, Videometer will provide a modified version of the VideometerLite system (VideometerLite - Videometer), shown in Figure 1, that will be used to collect data as input for the project iFMS. VideometerLite is a portable and wireless spectral imaging device designed for easy, straightforward, and accurate image analysis.

Figure 1. VideometerLite, portable handheld multispectral imaging device.

With its state-of-the-art technology, the instrument allows for the determination of colour, texture, and surface chemical composition of up to 100x100 mm of sample size. Using strobed LED systems, VideometerLite efficiently combines the measurements of seven wavelengths into a single spectral image, where each pixel corresponds to a different reflectance spectrum, wavelength range [405-850 nm] – nonuniformly distributed. Thus it includes both visual and NIR wavelengths for a precise, accurate, and thorough quality inspection foods.

2.2 THE ATLANTIC SALMON VALUE CHAIN

The Atlantic value chain, defined in D2.1, includes all steps from farming to convenient, consumer-friendly value-added retail salmon products. Unwanted incidents and hazards along the value chain were identified in D2.1 and are the basis for the pilot design presented in section 3.1.

2.2.1 Site of sampling/data acquisition – Use case 1

Data acquisition will mainly be conducted from laboratory-designed experiments simulating different scenarios of unwanted incidents in the salmon value chain. Unwanted incidence includes factors such as 1) stress, poor bleeding, rough handling or rapid fish growth resulting in deviation of quality parameters, e.g. texture and colourimetric properties; 2) broken cold chain resulting in deviation of quality and food safety parameters. If possible to organise, a pilot following the cold chain of fillet transportation from the slaughterhouse in Norway to the European market (e.g. France) by trucks will be conducted.

2.2.2 Technological and sensor related issues and variables

Non-destructive analysis applying VideometerLight and the VideometerLab instrument will be conducted in tandem with traditional chemical, physicochemical, and microbiological laboratory methodologies (2.1.3) to assess the VideometerLight device's performance to measure different quality and safety parameters of salmon along the value chain. Temperature and pH will be monitored with in-house portable loggers.

Different instruments will be applied to verify the results obtained by VideometerLight. Examples are DigiEye System to measure the fillet's appearance (e.g.melanine-and blood spots) and colour, and the samples texture properties will be measured by Texture Analyser TA-XT

2.2.3 Qualitative and/or quantitative variables

Traditional chemical, physicochemical, and microbiological laboratory methodologies that fit the specific experimental setup will be conducted. Relevant quality parameters include colour, texture, melanin-and blood spots, and fillet gaping. Microbiological quality will include analysis of aerobic plate counts (APC) and *Pseudomonas* counts, while *Listeria monocytogenes* will be used as a food safety indicator. The collected data fra traditional wetlab analysis will play an essential role in assessing the VideometerLight device.

2.3 THE ATLANTIC WHITEFISH VALUE CHAIN

The Atlantic cod value chain was identified and described in D2.1. The value chain will be monitored throughout processing of fresh and frozen fillets, lightly and heavily salted fish, as well as during processing of chosen side streams, such as cod liver oil or canned liver.

2.3.1 Site of sampling/data acquisition – Use case 2

Following conversations with stakeholders it was determined that samplings should take place throughout processing of the fish. Samples of fresh and frozen fillets and samples of lightly and heavily salted fish will be evaluated during processing, and analyzed with the VideometerLite and VideometerLab instruments.

2.3.2 Technological and sensor related issues and variables

Non-destructive analysis applying VideometerLite and the VideometerLab instrument will be conducted in tandem with traditional chemical, physicochemical, and microbiological laboratory methodologies (2.1.3) to assess the VideometerLite device's performance to measure different quality and safety parameters of the Atlantic cod along the assessed value chains. Temperature and pH will be monitored with in-house portable loggers. Near infrared (NIR) spectroscopy and low field nuclear magnetic resonance (NMR) measurements will also be applied side by side the Videometer technologies, and their prediction performances compared.

Several analytical techniques will be applied to verify the results obtained by the VideometerLite and VideometerLab instruments, including traditional microbiological and physicochemical methods. A similar setup as described in the salmon value chain will be used to allow comparison of results between the value chains.

2.3.3 Qualitative and/or quantitative variables

The sensitivity of the Videometer technologies to quantify the microbiological counts, physicochemical composition and characteristics, and to identify parasites will be investigated.

For microbiological assessments, focus will be set on total viable counts (TVC), while the assessment of individual species of mircoorganisms (H_2S producing species, Pseudomonas, etc.) will be applied where appropriate in the defined fresh/frozen, salted and cod liver value chains. Traditional physicochemical assessments of the proximate composition, water holding capacity, water activity, pH, texture, colour and water and lipid distribution (Low field NMR) will be applied throughout the processing.

2.4 THE MEDITERRANEAN SEABREAM/SEABASS VALUE CHAIN

Using the D2.1 where the identification of hazards of interest by the related stakeholders in Mediterranean seabream/seabass took place along with the actual step by step mapping of the corresponding value chain, we outline here the findings closely related to the pilot design.

2.4.1 Site of sampling/data acquisition – Use case 3

As it has been captured by the stakeholders of the seabream/seabass value chain, it consists of farming, harvesting processing, retailers and reach to the end consumers. Thus, the sites of sampling would/should be the in-between points of them and in addition, we are going to "simulate" different time period at storage conditions and transportation (also at storage conditions) of the products. Apparently, the products may are different from the raw material, i.e. raw whole fish at harvesting time. So, we intent to also sample both raw material and processed ones, meaning fish fillets.

2.4.2 Technological and sensor related issues and variables

In order to ensure the applicability and feasibility of the VideometerLite sensor along the value chain at the abovementioned sampling sites. For the experimental design in the context of the related pilot, we will use the VideometerLight instrument, in tandem with VideometerLab instrument that has been used in AUA's premises for much longer time for data acquisition and data lake population. as well as traditional chemical, physiochemical, and microbiological (TVC, listeria, Pseudomonas) laboratory methodologies that fits the specific experimental setup.

2.4.3 Qualitative and/or quantitative variables

In order to assess any probable and emerging adverse effect of contaminants along the fish value chain, qualitative and quantitative metrics will be employed throughout the pilots, as incorporated in their design (please refer to following section for details). Specifically, in terms of quantitative variables, TVC, populations of individual species of microorganisms will be recorded via traditional, state-of-the-art analytical microbiology approaches. Examples of microorganisms implicated in the analysis are Enterobacteriaceae (e.g. E. coli), Pseudomonas spp., lactic acid bacteria, yeasts, moulds and sulphur producing bacteria. Further in terms of qualitative measurements approach, subjective quality metrics such as odor, appearance and texture of the products, sensory based quality evaluation/reporting will be performed simultaneously to the analytical microbiological assessment. This assessment will be performed via questionnaires that we will require to be filled by several trained and non-trained persons with regards to several properties of the products, e.g. their smell, appearance etc. The collected information, will be used as reference towards the apparent overseen quality, in tandem with the quantitative assessment of microbiological abundance via traditional microbiological in lab analysis. Finally, it should be stated that the imaging spectral data acquired will play the role of predictor variables during the model development process, which can refer to both qualitative and quantitative response variables, i.e. questionnaires' answers and wetlab microbiological analyses

3 PILOT DEFINITION & DESIGN

This section is about the overall design of the pilots' scheme that will be applied across the project, in terms of the three use cases considered in the project. Thus, by incorporating also the information extracted and accumulated in Task 2.1 (as reflected and expressed in D2.1). The three use cases will be harmonised under a common pilot design since apart from the raw first material (type of fish), the rest of the value chain remains more or less the same. As state in the proposal, Task2.2 and consequently the two related deliverables is divided in terms of time, into two periods. Herein, i.e. the very early period, will be dedicated to the design of the pilot studies and particularly their design and specifications (for the calibration data acquisition), while the second one (D2.4) will serve as an adaptation and finalisation of the pilots towards the acquisition of the evaluation and demonstration data towards the evaluation of the TMF platform.

3.1 THE ATLANTIC SALMON VALUE CHAIN

In this Section we provide the designed workplan, which also will serve as a data acquisition process pipeline, data that will be used for the development and validation of the prediction/estimation models in the case of the Atlantic salmon value chain. The sampling protocols include small and medium scale experiments simulating unwanted incidents and hazards along the value chain (the sampling plan is tentative and will be updated according to collaboration with other ongoing projects/activities).

3.1.1 Issus related to stress/fish handling

Stress and rough handling of fish affects textural and colorimetric properties. In this experiment we will simulate long term rough handling by stressing the fish daily for one month to measure how these treatments affect fish pigmentation, coloration, and texture. We aim to use the VideometerLite and VideometerLab systems and confirm measures with traditional wet-chemistry methodologies. The experimental setup is a part of a project funded by the Research Council of Norway (project nr 174260) that can provide experimental fish to our project. The experiment will be conducted in June 2022.

3.1.2 Issus related to soft texture and blood

Soft texture is affected by a range of parameters including stress, rough handling and rapid growth. To study the effect of growth we aim to set up an experiment comparing textural properties related to growth parameters. We aim to use fish from NTNU's research farm by sampling fish in November 2022 (after an extensive growth period) and in March/April 2023 when the growth is less significant. In this experiment we will also include meassurs of residual bood, another parameter of significant interest for this project. To provoke differences in residual blood we will bleed the fish differently (from unbleed to commercial bleeding standards). We will use the VideometerLite and VideometerLab systems and confirm measures with traditional wet-chemistry methodologies.

3.1.3 Issus related to a broken cold chain

To chill the fish properly and to keep the cold chain unbroken is essential to remain quality from farm to fork. We aim to set up 2-3 small scale experiments simulating different incidents related to a broken cold chain (e.g., slow chilling, melting of ice/re-icing, short term heating, etc.). We will use the VideometerLite and VideometerLab systems and confirm measures with traditional wet-chemistry and microbiological methodologies. The experiments will be conducted in Q1/Q2 2023. It might also be an option to include measures from another ongoing project (FHF - Norwegian Seafood Research Fund, project nr 901 778) following the cold chain (trucks) from the processing plants in Norway to the European marked.

To follow up hazards identified in the initial part of the project (WP2 – Task 2.1) we will include parameters such as melanin and blood spots, soft texture, temperature control, and predicative and experimental microbiology. For the experiments we will use the VideometerLight and VideometerLab equipments for data acquisition as well as traditional chemical, physiochemical, and microbiological (APC, listeria, Pseudomonas) laboratory methodologies that fits the specific experimental setup of interest.

3.2 THE ATLANTIC WHITEFISH VALUE CHAIN

In this Section we provide the designed workplan, which also will serve as a data acquisition process pipeline, data that will be used for the development and validation of the prediction/estimation models in the case of the Atlantic cod value chains. The sampling protocols include small and medium scale experiments simulating quality changes along the value chain (the sampling plan is tentative and will be updated according to collaboration with other ongoing projects/activities).

3.2.1 Fresh and frozen fillet processing

The main focus in the TraceMyFish project will be laid on the analysis and monitoring of the fresh and frozen fillet production at BRIM in Reykjavík. Samples will be taken throughout the process and analyzed with the VideometerLite and VideometerLab instrements, along with a range of traditional microbiological and physicochemical reference analyses to obtain a detailed overview of the quality changes occurring and identifying potential hazard points during processing. The obtained data from the Videometer technologies will be compared to the traditional quality assessment method results to investigate the strength and accuracy of potential quality prediction models built from the acquired spectroscopic and image analysis data. The sensitivitiy of the TraceMyFish technologies to identify parasites (such as nematodes) will also be assessed in collaboration with the Icelandic research project "Greining á hringormum í flökum / Assessment of nematodes in fillets", which is funded by the Icelandic Food Research Fund/Matvælasjóður.

These trials are planned to take place in September 2022 and in February 2023, to account for seasonal variation within the raw materials.

3.2.2 Salted Atlantic cod

The physicochemical changes occurring during salting of cod are more extreme than during the fresh and frozen filleting processing, and thus provide more width in the potential uses of the Videometer technologies for process monitoring. Samples from the light salted and chosen heavily salted value chains will be collected and analyzed and compared to the same microbiolocial and physicochemical reference measurements as mentioned in section 3.2.1. This will allow the construction of both holistic and specific prediction models within the white fish value chains. In addition, parameters assessing protein quality changes will also be assessed in these trials. These experiments are scheduled to take place in October-November 2022.

3.2.3 Cod liver oil and/or canned liver

To follow the extremes in the lipid characteristics within the white fish value chains, chosen samples from the cod liver oil and/or canned liver production will be assessed. In addition to earlier mentioned quality assessments, quantification of fatty acid compositions and of oxidative products (PV, AV and/or TBARS) will be performed. This experiment is scheduled to take place in spring 2023.

3.3 THE MEDITERRANEAN SEABREAM/SEABASS VALUE CHAIN

In this Section we provide the designed workplan, which also will serve as a data acquisition process pipeline, data that will be used for the development and validation of the prediction/estimation models in the case of the seabream and seabass value chain.

Samples of fishes will be monitored for microbiological contamination using the VideometerLab and VideometerLite instruments (please refer to D2.1 for more details on the employed instruments), while also they will be analysed with classical microbiological techniques, that will be used as the reference metrics, forming the "ground truth" of microbiological contamination levels. In addition and in order to meet complimentary stakeholders' needs (please refer to D2.1), subjective quality metrics such as odor, appearance and texture of the products, sensory based quality evaluation/reporting will be performed simultaneously to the analytical microbiological assessment. Sensory based quality evaluation, stands for questionnaire filling by trained and non-trained personnel concerning the quality of the products. This acquired information, although subjective and in many cases biased, will be used as reference towards the apparent overseen quality, in tandem with the quantitative assessment of microbiological abundance via traditional microbiological in lab analysis.

Regarding the objective side of the monitoring and quality of the products , the measurements from the sensors will be compared to those obtained by the analysis starting from fresh samples from the market. The samples will be acquired and purchased as fresh as possible directly from the market, they will be analysed again with the sensors and with the analytical microbiological techniques, to evaluate possible microbial contamination during transport (i.e. from harvest to fork modality). This way we will mimic/simulate the reality: fresh fish as they would originate from fish farms, microbiological assessment will be applied on time zero (fish acquisition) and after specific storage time and conditions (varying and fixed temperature) just like they would be treated along the shipping and distribution chain.

Traditional analytical strategies will be included to gain quality and safety data of the chosen products throughout their value chain. The conventional, current state-of-the-art wet-lab protocols for chemical, physiochemical, and microbiological measurements will be used as input to calibrate measures obtained by the sensing technology that the project aims to implement. To this end, experimental investigation of samples with gold-standard equipment (NTNU, AUA, UoI) will work closely together for the purpose of data collection across the blue value chain, in terms mainly to the possible hazards on microbial contamination and spoilage, quality assessment, and/or any other contaminants and pesticides introduced throughout the chain (as depicted in Section 2). Furthermore, prevention of food waste due to doubts in the cooling chain and pesticides of the process waste streams throughout the food chain.

The seabream/seabass value chain considered herein is comprised by several distinct stages (as depicted in Figure 2) in order to assess the quality and safety at the test/evaluation stages: (i) the place/stage of origin, the raw unprocessed product for pesticides and bacteria contamination, (ii) their transportation, (iii) processing and manufacturing, (iv) storage/packaging, (v) distribution of finished product(s), and (vi) placing on the market. Data acquisition will be performed through the multi-spectral imaging instrument VideometerLite provided by Videometer, a portable device that enables IoT capabilities able to acquire data at the sites of measurements, as they denoted earlier in tandem with traditional estimation methods for microbiological and chemical contaminations.

Figure 2. The Gilthead Seabream/European Seabass value chain.

More specifically concerning the laboratory measurements simulating the conditions of the food chain in reality (or at least as close to reality as possible), the following framework will be applied: multifactorial experiments (FT×PT×HT×T×P) that will represent the different stages across the food chain, will be designed and conducted in order to provide of each fish species considered, with real-like but with-in laboratory "controlled" conditions on every likely of emerging case of contamination and quality deterioration. Explicitly, the test points of quality and safety assessment are mainly correspond to the quality due to pesticides contamination and microbiological alterations, thus it is limited from samples acquisition, processing (i.e. filleting of whole fishes), transportation between them and storage and transportation among stakeholders, also correlating the products' end of life (expiration date). In order to reflect upon any emerging chain issues, sample under testing/experimentation (Factor FT – Food Type: fish species) will be stored at three (3) different temperatures and one (1) dynamic temperature profile (Factor T), under two (2) different packaging conditions (Factor P) – aerobic and modified atmospheres packaging, while also at least 2 different Harvest Times (Factor HT) will be considered. The aforementioned factors that will be included in the pilot along with the several sampling time points, serve as the key "real-life" simulator of the food chain. Specifically, factor FT serves the purpose of the two different fish species considered; Factor T (temperature) is the temperature profile that a product will be subjected to throughout its journey from harvest to fork. Factor P, referring to packaging of the products, simulates the effect of the different conditions within a packaging that would favor specific hazards, e.g. aerobic vs. anaerobic microorganisms, changing the phenotype of spoilage and consequently the sensor measurement profiles. This has an apparent effect on the performance and robustness of the prediction/estimation models since all, or at least the majority of the inserted variability on the measurements are needed to be taken under account.

Several sampling points for each treatment will be used for data collection of different measurements, consisting of (a) conventional microbiological counts (spoilage sub-use case) and freshness estimation, and (b) MultiSpectral Imaging (MSI). The measurements will be performed across the whole food chain, as defined earlier, under simulated conditions at first, to reach the feasibility results required, while on a second phase the models and the system can be validated in real life scenarios.

The fish will be acquired from local shops ensuring their freshness being as close as practically can be to the harvesting time point so as to cover the need to study time zero of contamination and freshness. The food samples will be undergone sampling measurements and will be spiked (if and where applicable) in an identical way for both the traditional measurements and the individual sensor measurements.

The information provided by the laboratory measurements and with the coupled portable spectral imaging instrument by Videometer, will and should be used in an ad-hoc mode, depending on the fish species and the type of quality and safety hazard considered (e.g. spoilage, contamination, origin identification etc.). Depending on the checking/measurement of samples site (along and in the considered food chain), the quality/safety across the food chain, different properties of deterioration extracted by the non-invasive sensor can be considered depending on the efficiency offered at each specific case, e.g. detection of fraud after product processing and prior distribution of the processed product or detection of safety hazards either after product processing or storage of the product. All the predicted properties, along with the use of available, custom and tailor-made data analysis approaches, for each type of fishes in tandem with the considered sampling point across the food chain, will be employed and serve as an efficient and robust tool for practical decision-making (helping the "intelligent" logistic of the products) and potentially even as an early warning system. It is obvious that this constitutes of a rapid, non-invasive, portable, analytical monitoring and tracking system that can be used at 'real time', when coupled with validated machine learning models, to monitor and predict safety at each stage of food production and even further, along the food chain, and to facilitate the prediction of the safety (concerning various hazards) of the products. It is thus obvious that herein, we focus on providing a framework along with a "closed"/standardized multi-sensor instrument for a novel food safety and quality monitoring decision-making system. This will be done by linking the current state of a product tested via the non-invasive Videometer MSI sensors (data collection), along to the history of the products (storage time and temperature across different time points).

Below we provide an example, case study, of an experimental design, as it will be applied during the pilots.

Assessment case study:
Microbiological quality of farmed seabass assessed using conventional microbiological methods and multispectral imaging analysis using VideometerLite.

Relative Task: Assessing the quality of fresh finfish throughout storage at different temperature conditions (0, 4 and 8, one additional dynamic temperature profile during storage, time-based changes in temperature, e.g. -→4→8→0… etc. – mimicking possible transportation conditions).

Material: Industry will provide 5-7 kg per batch of fresh finfish. A minimum of 30 fish will be analysed, with individual weights of no less than 200 g, to perform microbiological and MSI analyses. Moreover, fish of the same species will be obtained from different selling points and will be used for the validation of the results.

Methods: AUA will perform microbiological analyses, including total aerobes (TVC) and specific microbial groups such as Enterobacteriaceae (e.g. E. coli), Pseudomonas spp., lactic acid bacteria, yeasts, moulds and sulphur producing bacteria throughout the storage at different temperature conditions. Moreover, multi-spectral imaging analysis (MSI) will be evaluated as means of estimating the microbiological spoilage of these fish species.

Expected outcomes: Estimation of the microbiological quality of specific fish species. Additionally the acquired spectral data as well as the measurements (counts) of microbial consortium will be used for the development of models related to either fish quality classification or prediction of their shelf life.

4 CONCLUSIONS

Herein, we have extent the work took place in D2.1 v1.0, where we have identified the needs and requirements of the fish value chain actors. Thus, we present the identified variables along the three considered fish value chains, namely 1) the Atlantic salmon value chain, 2) the Atlantic whitefish value chain, and 3) the Mediterranean seabream/seabass value chain. Further we presented in brief the sensor that will be employed in the TMF project. Finally, a first pilot experimental procedure is defined and outlined, setting the basis for data acquisition with the main objective to be as close to reality (samples traveling along the food chain) in terms of conditions and possibly emerging hazards as depicted in D2.1. It should be mentioned that this is the first version of pilots design while further ajastments and amendments will be applied according the emerging needs and will be reflected in the second version, v2.0 of the D2.3, D2.5.