

TOPIC: Innovative sustainable solutions for improving the safety and dietary properties of seafood

CALL: BG-08-2017

EGOCREANET ACTS AS PROMOTER .
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ABSTRACT (massimo 2.000 c.)

Almost half of all seafood consumed globally is sourced from aquaculture and this trend is still on the increase. This could be attributed to consumers becoming more socially and ecologically conscious, steering away from seafood sourced using approaches that have led to the over-exploitation of natural populations. In fact, the increasing demand for seafood sourced from aquaculture industries means it is currently the fastest growing animal-sourced food industry, and thus, a major source of all proteins, vitamins and micro-elements required for a balanced human diet. Despite being the biggest importer of fish, seafood and other aquaculture products seafood markets in the world, European aquaculture production levels lag far behind the rest of the world. The EAT-BLUE project will implement a multi-directional and multi-disciplinary approach to improving and increasing European aquaculture activities including 1) extensive analysis of the current state of aquaculture policies and regulations within the EU; 2) optimised composition of the feed utilised in fish farming with focus on microalgae as the raw material; 3) exploring the use of probiotics in aquaculture with the aim of increasing nutrient uptake and reduction of disease in the fish which will increase growth performance of farmed fish, reducing the production cost per unit and improving the well-being of the fish; 4) introducing and optimising the cultivation of the common octopus and the greater amberjack as novel farmed species, and finally; 5) safeguarding and strengthening sustainable seafood production through market-driven and consumer-responsive activities. EAT-BLUE will place emphasis on dissemination activities, the exploitation of the results, and training of industry professionals, to ensure that the state-of-the-art research is readily applicable to the day-to-day running of commercial aquaculture facilities.

KEYWORD, Fisheries science, Seafood economy, Bioprocessing technologies (industrial processes relying on biological agents to drive the process) biocatalysis, fermentation, Nutrition, Dietetics

“EAT-BLUE”

“EAT AQUA-FISH and THINK BLUEconomy”

List of participants (to be confirmed)

PARTICIPANT NO.	PARTICIPANT ORGANISATION NAME	COUNTRY
1	Teregroup Srl Coordinator .	IT
2	EGO-Creanet c/o Business Incubator Florence University	IT
3	INVE, section of Rosignano Solvay	BE
4	Daithi O’Murchu Marine Research Station (DOMMRS)	IE
5	Istituto Español de Oceanografía IEO-CANARIAS (Tenerife)	ES
6	Universidad de La Laguna	ES
7	Fundacion CSIC	ES
8	Centre of Marine Sciences	PT
9	Instituto Português do Mar e da Atmosfera (IPMA)	PT
10	WFBR –biobased products	NL
11	Hellenic Centre for Marine Research	GR
12	Marine and Environmental Research Lab Ltd (MER)	CY
13	Trophix GmbH	DE
14	University of Belgrade, Faculty of Agriculture	RS
15	HZ University of Applied Sciences	NL
16	Norwegian University of Life Sciences (NMBU)	NO
17	NOFIMA	NO
18	Europe for Business Ltd	UK
19	University of Akureyri (UNAK)	IS

OUTLOOK

1. Aquaculture is the most promising investment and for a sustainable future of blue-revolution economy can generate benefits in local development based on circular economy by creating innovative solutions for "aquaculture" of various species of seafood. The development of aquaculture indirectly works in favor to the fish repopulation of the sea, and therefore aquaculture improvement represent a great challenge of eco-economic development of European food production.
2. Outlook: In today's world almost half of seafood comes from aquaculture, this trend is increasing the fish market, but also has to do with the conservation of species at risk of extinction caused by the super-exploitation of the capture of fish in the sea. Today with backwater fishing yields of capture and the growing demand for aquatic products, consumer expectations are very high for the development of aquaculture. Therefore, the project initially proposed by EGOCREANET, intends to contribute to increase the global production of fish food grown in fresh water or sea water, so that the European aquaculture can continue to strengthen its role in helping to sustain human health through a sustainable food supply high quality nutritional. So it will be decisive the commitment to develop eco-economy criteria to assert sustainability of new solutions for the aquaculture oriented to improve the safety and nutritional properties of seafood appropriately to

various fish species. One of the main objective of the project will be to improve and nutraceutical and probiotics properties of fish feed in order to ensure the health of both, human nutrition and for fish needs and their welfare.

3. Another important objective is to find innovative ways to expand aquaculture in the sea, particularly where the possibility of catching fish is low and steadily decreasing as in the Mediterranean.
4. The project entitled "EAT AQUA-FISH and THINK BLUEconomy" wants to compete in the global challenge of both nutritional and environmental aspects of aquaculture products, to develop innovative solutions to diversify mariculture products, to enhance sustainable and safe European aquaculture. This since the production of seafood will have become almost double over the next decade, therefore the project's activities will work to meet the increasing healthiness of seafood and to meet the growing demand of the world market. The project "EAT-BLUE want to develop the great potential of European aquaculture seafood, to contribute to food security, and meet the needs of nutrition as part of a sustainable and inclusive economic growth of the Blue Economy. In this way, the project is oriented to give an important contribution to the European challenge that aims to find ways to rethink aquaculture projects going over the contemporary state of the art , and to design new products and processes in order to meet the sustainability human nutrition and its growth through eco-economy in favor of a continued long-term innovation.
5. As a matter of fact aquaculture is currently the animal food industry's fastest growing production, and is in fact a growing source of protein, vitamins and micro elements for an excellent way to improve human nutrition.
6. Thus the future of seafood, production and industrial processing, will contribute substantially in a way that aquaculture and marine-culture, both will continue to strengthen its role in helping to sustain human health and the supply sustainable food.
7. Decisive in this context will be:
 - a) the development of eco-economy criteria for sustainable solutions to improve the dietary properties of the security seafood suitable for different fish species and, b) develop better and new products for the safety of seafood through the innovation of the composition of the feed for fish in order to improve the probiotic and nutraceutical properties of the fish to ensure both the nutritional and wellness needs of both animals and man 's.

Excellence

1.1 Objectives

Aquaculture remains the most promising sector for the sustainable growth of the 'blue-economy' phenomena. It emphasises the implementation of a circular economy by creating innovative solutions for aqua- and mariculture-based activities. The development and optimization of such industries indirectly benefits our natural ecosystems by allowing natural populations of fish and other aquatic species to repopulate.

Almost half of all seafood consumed globally is sourced from aquaculture industries (E-ISBN 978-92-5-108276-8 (PDF) © FAO, 2014), and this trend is still on the increase. This could be attributed to consumers becoming more socially and ecologically conscious, steering away from seafood sourced using approaches that have led to the over-exploitation of natural populations. In fact, the increasing demand for seafood sourced from aquaculture industries means it is currently the fastest growing animal-sourced food industry (FISH TO 2030 WORLD BANK REPORT NUMBER 83177-

GLB), and thus, a major source of all proteins, vitamins and micro-elements required for a balanced human diet.

Fish and other aquatic animals have amongst the best energy conversion rates with low carbon dioxide emissions, especially in comparison to land animals. Therefore, aquaculture can be considered a more sustainable method to supply our ever-increasing demand for protein ensuring food security for the growing global population. To keep up with demand, aquaculture production should therefore increase from 60 to 120 million tons in 2030 (FAO Expert Paper 2012: How to Feed the World in 2050). This will require continued access to raw materials (including fish feed) in an eco-economically sustainable manner, guaranteeing ecologically-friendly sources of nutritious and safe seafood from aquaculture. This includes the search for alternative sources of marine fish meal and fish oil, particularly to ensure that the seafood consumed by humans includes sufficient levels of long chain omega-3 fatty acids such as EPA and DHA essential for human health.

Led by EGOCREANET, the EAT-BLUE project is the uniting of 22 European institutions motivated to optimise European aqua- and mariculture industries to increase their contribution to the growing “blue economy” by implementing sustainable innovative approaches. The fundamental approaches set forth by EAT-BLUE to achieve this goal include: 1) development of innovative methods to prepare functional fish-feed from specific microalgae; 2) supplementation of fish diets with probiotics to improve the fish-welfare; 3) testing both the new feed composition and probiotic supplementation for some species of farmed fish; 4) expand aquaculture to new species, increasing diversity of farmed species thus improving the future sustainability of seafood production in a progressive eco-technological context; 5) find innovative ways of expanding mariculture in our oceans/seas, and finally; 6) emphasis on analysing the resulting data in order to increase consumer awareness on food quality, safety and its traceability, taking account the importance of consumer perception to safeguard and strengthen sustainable, innovation of seafood production through both market-driven and consumer-responsive approaches.

-->Classifying seafood aquaculture

Seafood is any form of sealife regarded as food by humans. It prominently includes fish, shellfish, and roe. Shellfish include various species of molluscs, crustaceans, and echinoderms.

See as reference <https://en.wikipedia.org/wiki/Seafood>

Aquaculture is very diverse, but operations can be broadly grouped by the following characteristics:

A) - By water type

This is mainly a distinction between marine and freshwater aquaculture. Marine aquaculture can also take place in brackish waters, where sea and freshwaters mix, as well as on land (e.g. in tanks).

B) - By species type

Species can be classified as ‘finfish’ (such as salmon or carp), shellfish (which includes bivalves, such as mussels, and crustaceans, such as prawns) or plants (such as seaweed or watercress).

C)- By intensity

In a semi-intensive system, managers supplement natural sources of feed. While In intensive aquaculture, managers supply the cultured species with all their feed. No feed is provided in extensive aquaculture as feed comes from the natural environment.

D)- By water flow

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In a closed system, such as a tank or enclosed pond, water is contained and may be tightly controlled and recirculated. In an open system, such as a sea cage or shellfish raft, water from the natural environment flows freely through the farm. In a semi-closed system, some water is exchanged between an enclosed site and the natural environment.

As a reference see

[:http://ec.europa.eu/environment/integration/research/newsalert/pdf/sustainable_aquaculture_FB11_en.pdf](http://ec.europa.eu/environment/integration/research/newsalert/pdf/sustainable_aquaculture_FB11_en.pdf)

1.2 Relation to the work programme

The EAT-BLUE project aims to address the points raised in the topic of “Innovative sustainable solutions for improving the safety and dietary properties of seafood”. Moreover, it proposes solutions for two main EU strategies:

1. **Encouraging “Blue” economy approaches.** “Blue Growth” is the long-term strategy to support sustainable growth in the marine and maritime sectors, including aquaculture, by maximising business creation.
2. **Fisheries and aquaculture EU Common Fisheries Policy (CFP).** This policy promotes a sustainable growth of fisheries and aquaculture in Europe which improves food security and quality for all European citizens through the smart management of fisheries, the diversification and profitability of the aquaculture sector, and the marketing of high quality and safe seafood products.

The EAT-BLUE project aims to take into account the future of aquaculture envisioned by the European Commission by implementing achievable goals and sound methodologies using the broad range of expertises of the EAT-BLUE consortium. Based on the issues highlighted by the BG-08-2017 call, the following statements will be taken into careful consideration:

- a) generate new scientific and social knowledge going beyond the state-of-the-art to share new findings, provide new commercial solutions for improving the socio-economic and environmental sustainability of the seafood production and processing industry in the regions where the activities take place;
- b) making fish farming more sustainable through the production of new species of seafood to address the need for food security for a growing human population;
- c) ensuring that food security and sustainable seafood production will increase the long-term profitability of the EU through the use of specific microalgae and/or insects as fish feed;
- d) increasing consumer awareness of food quality and safety, as well as animal welfare in order to increase the availability of healthier, safer and high quality seafood, improving consumer diet and health;

- e) the project will include TRL5 to TRL7 technology readiness levels for improved fish-meal and fry-feed production, as well as prototype and pilot activities for new products and aquaculture processes (including new fish species) to test pre-commercial viability;
- f) develop innovative ideas to use probiotics as dietary supplement to enhance the nutritional value of aquaculture products;
- g) address traceability, authentication and certification of EU seafood products and labelling quality;
- h) improve the professional skills and competences of those working to improve EU aquaculture keeping in mind all the points above;
- i) finally, a dissemination and exploitation plan will be developed and implemented to transparency of the research carried out during the course of the project, supporting opportunities for growth, diversification and job creation for the sector in general and SMEs in particular.

1.3 Concept and methodology, quality of the coordination and support measures

The overall level of wild-caught fish is in decline, particularly in the Mediterranean Basin. This has also coincided with an enormous growth in the number of products produced through aquaculture on a global scale. With Europe containing some of the most important seafood markets in the world, its aquaculture production levels lag far behind the rest of the world. Therefore, to cope with the **demand, the European Union is by far the worlds' biggest importer of fish, seafood and other aquaculture products.** EAT-BLUE will push to increase the competitiveness of EU partners and stakeholders in global aquaculture market.

Analysis of the approaches used and data generated by previous EU-funded projects in this field as well as extensive knowledge of the current state of aquaculture industries, with emphasis on the quality and nutritional value of the final product, will form the foundation from which the project will grow looking to all possible diffusion and exploitation of knowledge and know how:

See the following *synthesised* notes about the State of the art in EU-Aquaculture

Sinopsis FP6 : http://cordis.europa.eu/food/docs/2008-0699_en.pdf

FP7-Projects 2007/2010 : https://ec.europa.eu/research/bioeconomy/pdf/marine_sme_2011_v4.pdf

Focus on EU Aquaculture 2014-15 :

http://ec.europa.eu/fisheries/documentation/publications/h2020-2014-2015-focus-on-aquaculture_en.pdf

Recent EU Projects :

ARRAINA :feed-ingredients:

http://arraina.eu/images/ARRAINA/Media_Center/ARRAINA_1st_Technical_Booklet_web.pdf

AQUAEXCEL: <http://presse.inra.fr/en/Resources/Press-releases/Aquaexcel2020-New-Project-to-Facilitate-Transnational-Access-to-Leading-European-Aquaculture-Research-Facilities>

PRIMEFISH : http://cordis.europa.eu/project/rcn/193349_en.html

: http://www.primefish.eu/sites/default/files/PRIMEFISH_D7%20Communication%20Plan.pdf

EC-SAFESSEAFOOD : <http://www.ecsafeseafood.eu/>

The fundamental objectives of EAT-BLUE will address knowledge gaps that are limiting the sustainable growth of European aqua- and mariculture industries. The project will use a multidisciplinary approach by including partners with a wide range of expertises that will not only increase the quantity of the seafood produced but also the quality of the final product. This will contribute to the overall nutritional value of the seafood accessible to socially and ecologically conscious consumers. This will be achieved by:

- a) fostering relationships with players in the aquaculture industry with focus on SME, pushing for innovative thinking;
- b) increasing our understanding of the effects of aquaculture on the environment and *vice versa*, complemented by the management of the issues identified which will increase our knowledge of the eco-sustainable development of fish-farm production processes, also taking into account the effects of climate change on aquaculture;
- c) implementing innovative and optimal breeding patterns and genetic selection studies ensuring the nutritional value of the fish as well as their welfare;
- d) improving our knowledge of fish metabolism, physiology and intestinal microflora in order to develop new fish diets using innovative compositions of feed including the integration of microalgae for herbivorous fish, and insects and worms for carnivorous fish;
- e) analysing the nutritional composition of potential new feed ingredients identified for fish meal and fry-feed;
- f) developing functional probiotics/pre-biotics/nutraceutical properties in the fish feed to improve the welfare of the farmed fish as well as the nutritional value of the seafood consumed by humans;
- g) promoting the improvement in the veterinary care of farmed fish which directly affects the quality of the fish consumed by humans;
- h) diversifying the number of farmed species, beginning with the development of pilot-scale farming of Octopus Vulgaris and the Greater Amberjack;
- i) exploring new eco-friendly technologies for freshwater and seawater aquaculture practises;
- j) promoting consumer perception and awareness of new species of fish introduced into the market, emphasizing their potential nutritional value;
- k) continuing to improve consumer consciousness in order to dissuade unsustainable super-

exploitation of fish in our oceans and seas;

l) advocating for entrepreneurship and innovation to improve “blue growth” and job creation in the sector;

m) disseminating research results to the wider public to promote awareness of the potential of aquaculture in Europe.

Specific details of experimental methodology are described in the individual Work Packages in Section 3.1.

Regarding the coordination of the EAT-BLUE project, a bottom-up management method will be implemented. This strategy will strengthen the partnerships within the EAT-BLUE project. A bottom-up approach is radically different to the traditional top-down approach where the direction of the project is determined by a dominant coordinator. Instead, the bottom-up approach will require all partners to be proactive in every decision made within the project. This will allow every partner to communicate the methods they wish to implement to achieve their WP tasks and milestones. A bottom-up approach will allow all partners to support each other during the conceptualisation, implementation, and analysing phases of the project. Furthermore the EAT BLUE project will support gender equal access to management and resources and technical strategies developed/applied aiming to increase women empowerment in aquaculture programs, inclusion and benefits.

2. Impact

2.1. Expected impacts

The EAT-BLUE project hopes to improve on current knowledge of all steps involved in bringing seafood products to market; from fundamental research in fish breeding/farming to improved knowledge of seafood consumerism.

Policy-makers will be either directly or indirectly involved in the design stage of all experiments planned in the project. This will ensure that the expected results and protocols will not face any major hurdles for commercial implementation.

The project aims to improve the composition of fish feed which will affect the nutritional value of the final fish product for consumption. One of the critical challenges is ensuring that the feed contains high levels of poly-unsaturated fatty acids (PUFA) eicosapentaenoic acid (EPA; 20:5n-3) and docosahexaenoic acid (DHA; 22:6n-3), colloquially known as omega-3 PUFAs, at a low cost. Omega-3 PUFAs are important in human nutrition with health benefits such as reduced cardiovascular morbidity and mortality, reduced risk of premature births and improved cognitive and behavioural development of the foetus, as well as benefiting patients with atherosclerosis, hypertension, and neurological and neuropsychiatric diseases (Yashodhara *et al.*, 2009). One solution is to use microalgae as a source for fish feed as some species of microalgae are able to produce omega-3 PUFAs in high proportions of the total fatty acid content (Rebollosa-Fuentes *et al.*

2001). Furthermore, the improved fish feed will allow for lower production costs, thus, increasing the sustainability of aquaculture. microalgae is also exploited for its colouring capabilities such as the carotenoid astaxanthin which can pigment prawns, salmon and ornamental fish with a reddish colour. The market for this colourant alone was estimated at \$200 million in 2004 costing around \$2,500/kg (Spolaore *et al.*, 2006). Unlike β -carotene, the synthetic form of astaxanthin overshadows the natural form in the market due to its high production costs (Milledge, 2011).

Increasing global temperatures can be largely attributed to elevated CO₂ (Solomon *et al.*, 2009). Theoretically, microalgae are capable of utilising up to 9% of the incoming solar irradiance producing 280 tonnes of dry biomass ha⁻¹ year⁻¹ whilst sequestering roughly 513 tonnes of CO₂ (Bilanovic *et al.*, 2009). Implementing microalgal cultivation for the procurement of raw material for fish feed means that aquaculture will indirectly to be an active participant in the global efforts to reduce atmospheric CO₂ levels. ENEL Green Power is an Italian company that has shown preliminary interest to work as a stakeholder to carry out the pilot-scale cultivation of microalgae for the purpose of extracting and refining algal oil with high content of omega-3 PUFAs.

Although the use of microalgal-derived fish feed will suffice for omni- and herbivorous fish, it might not be sufficient for carnivorous fish. Currently, most fish and fry feed is sources from fish-waste that can contain high levels of chemical contaminants such as mercury (See as reference : <http://seafood.edf.org/common-questions-about-contaminants-seafood>).

The potential use of microalgae and protein from insects will ensure a clean source of feed that subsequently means a healthier and safer final fish product.

Disease in aquaculture remains a prevalent issue (see as reference : <http://www.agriskmanagementforum.org/content/disease-management-aquaculture> ; see tipology of fish diseases in : <http://www.eurl-fish.eu/>)

The issue of disease in aquaculture will be addressed by the EAT-BLUE project by the inclusion of probiotics in the fish diet to minimise disease and maximise nutritional uptake from the fish feed. Probiotics are microbial supplements that positively affects the microbiota of the fish gut which enhances the nutritional uptake from fish feed as well as supports the functionality of the fish immune system. Thus far, very little research has been carried out on probiotics in fish farming, with most of the research being limited to the use of lactic acid bacteria which have shown environmental benefits (Ptobiotics Fish-feed: ISSN (Online): 2320-9585, available in : <http://www.alliedacademies.org/articles/characterization-and-evaluation-of-probiotic-fish-feed.pdf>)

EAT-BLUE will utilise novel marine bacterial strains which have been shown to have a positive impacts on survival rates of various aquatic species including, shrimps, sea urchins, abalones, oysters and seabass under laboratory conditions knowing that the application of prebiotics and supplementary enzymes in fish feed is now gradually gaining importance in commercial aquaculture practices. (Supplementation of Probiotics in fish feed, available in : [https://www.researchgate.net/publication/235983099 Supplementation of prebiotics in fish feed A review](https://www.researchgate.net/publication/235983099_Supplementation_of_prebiotics_in_fish_feed_A_review))

The new generation of probiotics utilized in EAT BLUE project will permit to avoid the addition of antibiotics in aquaculture for safer seafood. This result will be measured as a decrease of 30% of fish mortality. Furthermore the expectation will be to get a measurable improvement of the immune state and the general health and well-being of Aquaculture fish and also to obtain a best nutritional values and a better seafood quality as it is requested by the REGULATION (EC) No 1831/2003 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 22 September 2003 on additives for use in animal nutrition.

Designing and testing new functional fish probiotics will be achieved by supplementing it to the everyday diets of established farmed fish including salmon, sea bass and sea bream, in operational farming systems. Increased efficiency of nutrient uptake and reduction of disease in the fish will increase growth performance of farmed fish, reducing the production cost per unit. Furthermore, probiotic microorganisms dispersed in water will aid in the general hygiene of the in aquaculture practices of fish farms. (Use of Probiotics in aquaculture, available in : <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3671701/>). Finally, the resulting data from the probiotics experiments will provide important information for fundamental fish research as well as contribute to EU food safety standards and legislation.

All EAT-BLUE partners will work together to promote the successful addition of new aquaculture products on the market by removing production bottlenecks for emerging species such as the common octopus and the greater amberjack by cooperating with previous EU-financed projects such as 'Diversify' (<http://www.diversifyfish.eu/species.html>).

The common octopus (*Octopus vulgaris* geographical distribution *All the Mediterranean and the Black Sea to the Atlantic over the eastern temperate.*) is a favourable candidate for aquaculture due to its short life-cycle and fast growth. Research has shown that it has a quick adaptation to captive conditions, with its feed efficiency and reproductive rates remaining high. The project aims to realize breeding of the *Octopus vulgaris* in captivity starting from the reproduction and to promote the rearing of the larval stages, the growth of juveniles until to the adult stage. This in order to make *Octopus vulgaris* a new profitable species for aquaculture industry combining the high demand of new species with a sustainable aquaculture starting from the exploitation of the results of Previous Projects see in: <https://www.was.org/EasOnline/Mobile/Paper.aspx?i=6474>)

Octopus has a high nutritional value and a high market price. It is well known for its low prices and for delicious tender texture and as very nutritious food. It is a good - high source of essential nutrients(12 different vitamins and minerals) It is a good protein source and low in fat. (see: <http://healthyeating.sfgate.com/nutrients-octopus-3006.html>)

The greater amberjack (*Seriola dumerili*) is a pelagic fish that can reach over 50 kg when fully mature (see : <http://marinebio.org/species.asp?id=462>). The fast natural growth rate and the speed reproduction cycle of greater amberjack makes it a new excellent candidate for aquaculture when compared to other popular species such as sea bass and sea bream (see: <http://www.diversifyfish.eu/greater-amberjack-seriola-dumerili.html>).

The high quality meat from the amberjack and its high market price has led to the increase in demand by the fisheries industry and, therefore, is greatly depleting the natural population of these

fish. (See : http://www.diversifyfish.eu/uploads/1/4/2/0/14206280/20140403_aquaculture_europe_vol_39.pdf).

The presence of this species on the market received a positive response from consumers, and the sheer size reached by this species in little more than a year of breeding means that the meat could be easily cut into user-friendly sizes and shapes, increasing its marketability. Increasing the number of greater amberjack reared in aquaculture facilities will not only provide new sources of income for the industry players, but this will also alleviate pressure from naturally occurring populations of greater amberjack.

The choices of the common octopus and greater amberjack as viable new aquaculture species was discussed intensely by all members of the EAT-BLUE consortium, and a strong socio-economic component beyond the biological and practical advantages were identified. Furthermore, the inclusion of Partner 22 (Aquaculture-Lampedusa) was not only motivated by their expertises, but also by their locality. The island of Lampedusa is point-of-entry for many economic migrants and refugees, particularly from Africa where food security is a constant and serious key issue (eradication of extreme poverty and hunger remains the number one UN Millenium Development Goals). In a world where a growing ammount of people, living in the poor countries , continue to suffer from chronic malnourishment and where the global population is expected to grow to reach about 9 billion people by 2050 the EAT-BLUE must contribute to meet the huge challenge of fast diversify the acquaculture for feeding our planet while safeguarding its natural resources for future generations. (E-ISBN 978-92-5-108276-8 (PDF) © FAO, 2014)

The farming of the novel species will be carried out in off-shore cages that place the farmed fish in direct contact with the natural marine environment. The EAT-BLUE consortium is fully aware of the implications of such mariculture methods and importance will be placed on the analysis and review of the protocols implemented. Infectious disease is a serious threat to both the farmed fish species and the natural aquatic species living in the vicinity of the fish farm. Therefore, the choice to focus on the common octopus and greater amberjack was made based on the careful analysis and evaluation of completed and/or on-going European-funded initiatives/projects

The previous funded projects demonstrate that to obtain a succes reproduction of those new species of aquaculture with no significant seafood diseases, it will be possible within an appropriate low culture density and a good water quality and an appropriated range of temperatures, those conditions are very important in order to promote low stress and mortality

EAT-BLUE will be able to build on the experience and results obtained from previous funded projects such as those previously *synthesised* the State of the art in EU-Aquaculture. In particular in relation to the Pilot-scale farming of novel species the choice of the production of new species in Aquaculture has highlighted the need to mitigate the risk- profile and the failure, starting from projects and partners of national and European projects already financed, but still lack a complete success. This in order to enhance skills and capacity of the management and development that are useful to go beyond the knowledge and know-how already acquired in this area of diversification of aquaculture in Europe. The sustainable and innovation production of nutritious and healthy products of aquaculture, surely will require the diversification of species available on the market. This will be the reason for investigate on the potential value of implementing in the EU-market the EAT-BLUE

introduction of two new aquaculture species, *Octopus vulgaris* and *Seriola dumerili* (Greater Amberjack) Furthermore the inclusion of new species of EU-aquaculture aim to alleviate pressures on the capture of wild fish populations and also to get an important impact on the decreasing our dependency of these imported products.

EAT-BLUE will hope to improve the current protocols and practices used in large-scale offshore mariculture industries, minimising the effect on the local environment. This result can be enriched by following the principles of co-cultured multiple species in their environment through an Integrated multi-trophic aquaculture (IMTA). In fact the idea is to create a healthy marine ecosystem, able to focus on the environment remediation (bioremediation), and to economic stability (improved output, lower cost, product diversification and risk reduction) and to social acceptability (better management practices). To diversify aquaculture from a traditional seafood production business into an IMTA system, to better understand the conditions that EATBLUE will promote for improving the development at a commercial scale of IMTA in Europe.

See <http://www.int-res.com/articles/aei2016/8/q008p191.pdf>;

Furthermore a fundamental goal of the EAT-BLUE project is to guarantee that the different actors involved in the seafood value chain systems (e.g. representatives of the industry supply chains, consumers, NGOs, EU- and Regional administrations, etc.) participate in the conceptual stages of the project to ensure that the results of the project fit their needs and requirements.

EAT-BLUE will provide on-site and online training courses as part of its dissemination efforts to promote skills that will emphasise the importance of innovation in the European aquaculture industry, and ensure a well-rounded, multi-faceted new generation of players in the aquaculture industry.

Increasing our understanding of consumer perception will allow for the creation of better consumer awareness. Extensive dissemination and outreach activities will provide vital information regarding the benefits of farmed seafoods and how to choose quality fish to ensure traceability and safety to ensure improved practices throughout the value-chain as well as promoting the contribution of fish to global food security issues. The project hopes to improve the competitiveness of European aquaculture products on a global scale.

2.2. Measures to maximise impact

2.2.1. Dissemination and exploitation of results

The dissemination and exploitation of results are a vital tool for the success of EAT-BLUE. The use of online tools such as a website, newsletters, and active blogs and vlogs will involve the general public in all phases of the project. The project wants to ensure that the motivation behind each approach is understood by all players of the seafood value chain (representatives of the industry supply chains, consumers, NGOs, EU- and Regional administrations, general public), and feedback from all parties be taken into account. This will establish a rapport with all players so that when the novel feed and seafood species are commercialised, they understand the development process behind their place in the market.

Awareness of issues related to biodiversity, climate and environmental change with relation to aquaculture will be achieved in the form of user-friendly websites and leaflets. Additional awareness of the positive effects of aquaculture will be focused on local communities directly affected by the presence of aquaculture in the area. This can be achieved via open-days at aquaculture facilities, holding talks at local schools and at public offices.

EAT-BLUE will provide on-site and “online training courses” as part of its dissemination efforts to promote skills that will emphasise the importance of innovation in the European aquaculture industry. The workshops will be available to all people; from aquaculture specialists to policy-makers and the general public. The content of the workshops will range from highlighting the importance of innovation in aquaculture and how such innovations can aid in diminishing overfishing and improve waste management from aquaculture industries, and contribute to decelerating climate and environmental change. Workshops discussing aspects of traceability, authentication and certification of EU seafood products, and labelling will also be organised. Gender-specific issues in the aquaculture industry will be highlighted in all workshops

The on line course of will think as an investment the goal to increase the capacity of women to engage in all aspects of new aquaculture systems technology . The achievement of the women's empowerment it is important to get a deep impact on social and employment advancement of the Blue Economy strategy.

Practical workshops will also be organised to allow all participants to understand the work carried out by members of the aquaculture industry. All participants should leave these workshops with a multidisciplinary understanding of fish-farming approaches and issues.

The workshops will be held by partners EGO and IEO, MER and INVE and which all have expertise in unique fields. Each workshop will have a maximum of 20 participants to allow for hands-on training of each participant .

A special summer school will be organised aiming to improve the professional skills and management competences for young EU entrepreneurs as well as from young graduates in any field that wish to join the aquaculture industry. The summer school will be organised in 2017 in Livorno, Italy (Villa Celestina, Pineta Marradi Castiglioncello), and we anticipate roughly 30 participants .

Dissemination of EAT BLUE research results to the scientific community will be carried out by publications in high-impact on scientific journals. As ELSEVIER and other on line reviews :<https://www.elsevier.com/journals/aquaculture/0044-8486/open-access-options>. Where possible, the articles will be available via open-access in order to promote an increased application of the findings that can lead to greater impact on aquaculture growth and development eg: World Aquaculture Society : <https://www.was.org/View/Open-Access-Publishing-in-the-Journal-of-the-World-Aquaculture-Society.aspx>

[illegible]

2.2.2. Communication activities

Communication and promotion of the EAT-BLUE project findings will be carried out in the form of a website, newsletters, and active blogs and vlogs, as well as open-days at aquaculture facilities, holding talks at local schools and at public offices.

The scientific community will be made aware of the project findings via high-impact scientific journals such as, and all articles will be open-access. The active participation of all EAT-BLUE partners at international conferences via poster and oral presentations will be encouraged.

“Fisheries and Aquaculture Journal” , an open access, peer reviewed journal with the central theme of fish biology.[ee http://www.omicsonline.com/open-access/fisheries-and-aquaculture-journal.php](http://www.omicsonline.com/open-access/fisheries-and-aquaculture-journal.php)

“The Fish Site” , Sustainable aquaculture magazine ; <http://www.thefishsite.com/>

Pesci In Rete (Aquaculture on line magazine (in Italian) ; <http://www.pesceinrete.com/>

Constant and clear communication with all vital players of the seafood value chain will allow for the whole aquaculture industry to be up-to-date with the findings of the experiments being carried out by EAT-BLUE. Interactive tools such as blogs, vlogs and online forums will ensure that information and advice is easily and quickly available. Such platforms will promote external partnering, networking and collaboration, allowing industry professionals and young graduates to implement and exploit the results as soon as possible. Care will be taken to protect any intellectual property .

Exploring the role of intellectual property rights.

As Intellectual property (IP) of the EAT BLUE project means : information, ideas, inventions, new fish varieties, innovations, prototypes, designs, know how and any other matter or thing whatsoever that belong to a creation of the partnership activities made by the project Consortium. All these activities will be considered of legal protection or the subject of legal rights, as granted by national and European laws and which may include the following items: patents but also information which has been communicated in such a way as to give rise to a duty of confidentiality in order to prevent individual or collective entrepreneurship belonging to the project EAT-BLUE. Furthermore the EAT BLUE Consortium will protect the strategic management including this in IPRs as a key determinant of success in aquaculture development proposed by the project . Each partner of the Consortium will agree to sign a disclosure agreement that assure the strategic management will be protected as an IP's asset in relation to the following issues: (i) conceiving new ideas and transforming these into marketable products and services;(ii) successfully marketing sea-food products and services efficiently and cost effectively;(iii) gaining, maintaining and sustaining their competitive advantage in markets, whether these are local, national, regional or international.

3. Implementation

3.1. Work plan – Work Packages and deliverables

WP1. Going beyond aquaculture development.

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WP1 will focus on the policy and social aspect of the European aquaculture sector. Extensive analysis of the current state of policies within the EU will allow for the identification of weak spots that may hamper the advancement of aquaculture in Europe. The work package will concentrate on regional policies affecting all aspects of aquaculture. The involvement of farmers, fishermen, consumers, public authorities and society-at-large will be the key to ensuring the needs of all players in the field are met.

Policies for the inclusion of novel fish feed as well as novel species of seafood from aquaculture will be a key aim for this work package. The novel feed and farmed seafood must meet all EU regulations and standards ensuring the welfare of the seafood as well as the well-being and safety of the consumer.

WP1 will also provide guidance for all experimental planning and execution carried out in all other work packages guaranteeing that all innovative activities truly respond to the societal and environmental challenges set forth by the EU “Blue” economy growth strategies.

Stakeholder interactive engagement will ranged from all stakeholder aiming to empowerment of the project know how. This goal will be obtained through invitations to take part in a dialogue ,and panel discussions with EU governamental and other non-governamental actors and aquaculture associations as FEAP (*) Such initiatives will be critical for developing processes that can underpin the inclusion of stakeholder’s knowledge to participate at international meetings organized by the WP on dissemination and exploitation on the issues regarding safety and innovation in aquaculture in order to ensuring more accountable, transparent and informed policy making of future European and global seafood development .(*) EGOCREANET has a friendly relationship with the current President of the FEAP, dr. Marco Gilmozzi).

WP2. Novel sources of nutrition : selected microalgae and other valuable raw materials.

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Partners: 1) Teregroup srl, www.teregroup.net, Italy (SMS), General Coordinator, <michael.magri@teregroup.net> <http://www.teregroup.net/>, 2) DOMMRS -Marine Res. Station Ltd; <http://www.dommrc.com/staff-profiles.html>, Ireland, “Scientific coordinator” : Dr. Julie Maguire <julie.maguire@dommrc.com> and Fiona Moejes <fionamoejes@hotmail.com>

An optimised composition of the feed utilised in fish farming is essential to producing high quality seafood products. However, fish feed represents a significant proportion of the production costs in aquaculture which can lead to the farmers ‘cutting corners’ and using low-cost low-quality feed. WP2 aims to develop novel sources of raw material for fish feed, with focus on microalgae. One of the critical challenges is ensuring that the feed contains high levels of poly-unsaturated fatty acids (PUFA) eicosapentaenoic acid (EPA; 20:5n-3) and docosahexaenoic acid (DHA; 22:6n-3), colloquially known as omega-3 PUFAs, at a low cost. One solution is to use microalgae as a source for fish feed. Some species of microalgae are able to produce omega-3 PUFAs in high proportions of the total fatty acid content (Rebollosa-Fuentes *et al.* 2001). By working closely with WP1, this work package hopes to identify suitable microalgal candidates for feed and assist in ensuring that they are authorised for use by the EU. Thus far, the EU has authorised the use of oil from the microalgae *Schizochytrium sp.* as an alternative source of essential fatty acids (see Regulation (EC) No. 258/97 of the European Parliament and of the Council repealing Decisions 2003/427 / EC and 2009/778 / EC).

Although the use of microalgal-derived fish feed will be suffice for omni- and herbivorous fish, probably it might not be sufficient for carnivorous fish. Currently, most canivorous fish and fry feed is sources from fish-waste that can contain high levels of chemical contaminants such as mercury (see: https://en.wikipedia.org/wiki/Mercury_in_fish) . The potential use of microalgae witin an addition of protein from insects will ensure an optimized source of carnivorous fish feeds that subsequently give rise to a healthier and safer final fish product. The WP1 will explore fish-feed for promising alternative for carnivorous finfish using an mix of microalgae, and insect/bugs or microbes, or of some yet- not developed combination. See more at Global Aquaculture : <http://advocate.gaalliance.org/buggin-out-tapping-the-potential-of-insect-meal-in-aquaculture/#sthash.C0zhWAnR.dpuf>

WP3. Supplementation of fish-food with probiotics.

Leader WP3 and Steering Committee Coordinator : stephen.hennart@trophi.org

Partners: 1) WFBR –biobased products,www.vcard.wur.nl, The Neetherlan, Dr. Ana Lopez Contreras : <ana.lopez-contreras@wur.nl>, 2) Norwegian University of Life Sciences (NMBU), <https://www.nmbu.no/>; Norvege, Prof. <Ashild.Krogdahl@nmbu.no>

Probiotics in fish feed is a relatively unexplored field. The nutritional composition as well as the health of the fish reared on the novel feed will be compared to those fed on traditional feed. Probiotics are microbial supplements that positively affects the microbiota of the fish gut which enhances the nutritional uptake from fish feed as well as supports the functionality of the fish immune system. Designing and testing new functional fish probiotics will be achieved by supplementing it to their everyday diets. Increased efficiency of nutrient uptake and reduction of EAT-BLUE

disease in the fish will increase growth performance of farmed fish, reducing the production cost per unit. Dietary supplementation of different feed additives such as immunostimulants, probiotics and prebiotics, usually in small quantities, has been found to be beneficial for improving immune status, feed efficiency and growth performance of crustaceans and finfishes (See: Digestive physiology in fish gut: <http://www.ijrbp.com/file/2013%20Volume%201,%20issue%202/IJB-2013-1-2-15-16.pdf>). As with the novel feeds, microbial supplements will be subjected to standard legislation and recommended practices as set by the EU by working closely with WP1. Not only will WP2 explore potential species that could be utilised as fish probiotics, it will also develop optimal delivery methods.

WP2 will provide the basis for WP3 where the novel feed and developed probiotics will be used in pilot-scale trials .

WP4. Validation of novel feed and probiotics to familiar aquaculture EU-finfish

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Pilot-scale cultivation of microalgae for selected strains testing in WP2 will be carried by WP3. The potential use of pre-existing commercial-scale cultivation facilities will provide an estimated yet comprehensive production cost for the raw material. Furthermore, the microalgal-based feed will be used on established farmed fish species such as salmon, sea bass and sea bream, and their growth and general well-being compared to those fed on traditional fish feed. Statistical analyses of the data generated will provide insight into the success of the microalgal-based feed and allow for effective costing of the novel feed based.

The same approach will be utilised to test the effectiveness of the supplementation with probiotics on established farmed fish species at a pilot-scale.

Emphasis will be placed on revealing the nutritional value of the fish once ready for market. This will provide the groundwork for pursuing EU policy allowing the use of novel feed and probiotics in aquaculture by working closely with WP1.

Pilot-scale fish-farming of new species are justified by the following principal concepts .The sustainable and the continuous production of aquaculture products will require the diversification of species available on the market. EAT BLUE project will investigate the potential of two new aquaculture species, *Octopus vulgaris* and *Seriola dumerili* (Greater Amberjack) with the scope of including other new species in the EU- aquaculture market. The diversification of fish species is one of the strategic objectives for the contemporary development of aquaculture, This will alleviate pressures on wild fish populations whilst decreasing our dependency of imported products. Furthermore successful approaches will allow for the development of pilot-scale fish-farming of *Octopus Vulgaris* and *Seriola Dumerili* (Greater Amberjack). The common octopus is a cephalopod characterized by a short longevity and by a fast-growing and it is widely distributed through the world. It represents an important resource with high economic value. The greater Ambejack is well known for high nutritional values appreciated by the consumers , containing good proteins with a

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low saturated fat , and good ratio of unsaturated Omega3/6

WP5 – Novel species of aquaculture : Octopus Vulgaris

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The common octopus (*Octopus vulgaris*) is a favourable candidate for aquaculture due to its short life-cycle and fast growth. Research has shown that it has a quick adaptation to captive conditions, with its feed efficiency and reproductive rates remaining high. Octopus has a high nutritional value and a high market price. Unfortunately, attempts at sustainable octopus farming relied on paralarvae rearing, a delicate early stage of development which was shown to suffer almost total mortality at around day 30 when in captivity ([Current status and future challenges in cephalopod culture : http://calocean.icm.csic.es/sites/default/files/PDF/Villanueva_et_al_2014.pdf](http://calocean.icm.csic.es/sites/default/files/PDF/Villanueva_et_al_2014.pdf)). WP4 aims to improve our knowledge of paralarvae rearing in cephalopods using physiological, molecular and genetic tools to understand gene expression, epigenetic regulation, digestive physiology and biomarkers involved in immune and stress responses.

WP6- Novel species of aquaculture : Greater Amberjack

Leader : Dr. Demetris Kletou (MER)dkletou@merresearch.com

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The greater amberjack (*Seriola dumerili*) is a pelagic fish that can reach over 50 kg when fully mature. Greater amberjack are migratory fish found in the open ocean forming large schools especially when they are at a young age.

The fast natural growth rate of greater amberjack makes it an excellent candidate for aquaculture when compared to other popular species such as sea bass and sea bream. The high quality meat from the amberjack and its high market price has led to the increase in demand by the fisheries industry and, therefore, is greatly depleting the natural population of these fish. Furthermore, the presence of this species on the market received a positive response from consumers, increasing demand. However, the natural migration of this fish and overfishing in recent years means that it is no longer possible to supply to meet the demand.

The sheer size reached by the greater amberjack in little more than a year of breeding, means that the meat could be easily cut into user-friendly sizes and shapes, increasing its marketability. Recent advances in marine aquaculture over the last few decades have provided increasingly sophisticated systems for offshore aquaculture in the open sea allowing for the successful breeding of such large-sized species of fish that have excellent swimming ability and, thus, a need for space.

The EAT-BLUE consortium has a number of experts in the field of greater amberjack larval rearing, particularly Dr Constantinos Mylonas from the Hellenic Centre for Marine Research that has worked on the development of larval rearing protocols for the greater amberjack (see

<http://www.diversifyfish.eu/greater-amberjack-seriola-dumerili.html>).

The goals of WP4 in relation to the WP5 on greater amberjack are to develop reliable reproduction in captivity and produce adequate numbers of juveniles. This will be achieved by firstly facilitating the successful breeding of adult amberjack for the collection of eggs, either in on-land large tanks or in cages in the open sea (it has been shown that the eggs are buoyant and can be easily collected). The collected eggs will be transferred to special hatcheries where they are reared from larvae to fry with a diet of natural feed. The fish fry will then be carefully moved into larger tanks on-land until they are about 100g in size when they will be transferred to off-shore cages and fattened. Data on mortality and health of the fish larvae and fry will be meticulously collected. In a parallel step, WP4 will work closely with WP2 and WP3 to develop suitable feed for the greater amberjack, including the nutritional composition of the feed as well as ensuring appropriate pellet size for each stage of growth. EAT-BLUE will work closely with specialised fish feed companies see: <http://www.inveaquaculture.com/>).

The end-goal of WP5 and WP6 is to have TRL5/7 level demonstrative prototypes. Finally, WP5 will work closely with WP6 to positively market farmed octopus as well as ensure a positive consumer response to the greater amberjack meat.

WP7. Consumer perspectives ,expectations & performances.

Leader : HZ University of Applied Sciences, www.hz.nl, The Netherlands, Dr. Jasper Van Houcke < j.van.houcke@hz.nl >.

Partner : Universidad de La Laguna , www.ull.es, Spain (PB) ,Dr. Rodriguez Covadonga : <covarodr@ull.es>

Safeguarding and strengthening sustainable seafood production through market-driven and consumer-responsive activities is the key to the success of EAT-BLUE. Addressing challenges such as increasing consumer awareness of food quality and safety, as well as traceability and animal welfare remain the main motivation behind the innovative ideas of the project. The socially and ecologically conscious consumer wants to know that the farmed fish which they are purchasing and consuming is safe, of a high quality, and has more health benefits than their caught counterparts. Such consumers want to be informed of the well-being of the fish when it was in its respective aquaculture facility, and how much of an impact their purchase has on the environment and the natural fish populations. WP5 will work closely with all work packages, particularly WP1 and WP4, to identify and review the aforementioned areas in relation to novel and innovative aquaculture trends.

WP8. Outreach and dissemination activities

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Partners : All partners and WP leaders.-

Working in parallel with WP1, WP6 aims to guarantee that the different actors involved in the seafood value chain systems (e.g. representatives of the industry supply chains, consumers, NGOs, EAT-BLUE

EU- and Regional administrations, etc.) participate in the conceptual stages of the project to ensure that the results of the project fit their needs and requirements.

WP6 will also ensure that a clear and concise website is set up that will be actively updated. Leaflets and project newsletters will also be designed and distributed. News of the on-going projects within EAT-BLUE should be pitched to local newspapers to increase public knowledge.

-----Reviewed by -----Paolo Manzelli and Fiona Moejes stop . 18/JAN/2017 -----