ICA PROJECT NO. ENV- 25686 A-12 (2013)

FINAL REPORT

Canakkale University Copper Alloy Demonstration Farm

November 2014

Comparison of Growth Performance and Feed Utilization of Rainbow trout (*Oncorhynchus mykiss*, W., 1792) in Freshwater and Seawater with Environmental Effects for Life Cycle Assessment in Offshore Cage Systems with Copper Alloy Netting in the Northern Aegean Sea

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INTRODUCTION

The organic growth on marine cage systems and fish nets is one of the most important challenges the aquaculture industry is facing. Due to the organic growth on the fish net, the blockage and the reduced size of the mesh, water flow through the system is being reduced causing a reduction in the oxygen level in the cage environment as well. The result under this condition is lower feed intake, reduced growth performance of fish, and lower income and less overall benefits. A more sanitary environment translates into reduced stress for fish because of fewer net changes and reduced labor for cleaning.

For the improvement of the European aquaculture industry, research on offshore marine aquaculture systems and alternative materials has been conducted in collaboration of Canakkale Onsekiz Mart University in Turkey and the University of New Hampshire, Mechanical and Ocean Engineering Departments in the USA. The research location in the Strait of Canakkale (formerly, *the Dardanelles*) (40°03'42"N - 26°20'36"E, 40°03'51"N - 26°20'45"E, 40°03'45"N - 26°20'55"E, 40°03'36"N - 26°20'48"E) withstands approximately 12 storms each year, resulting in three to five meter-high waves. Additionally, the water flows in both directions along the strait, from the Sea of Marmara to the Aegean Sea, forcing a surface current in one direction and an undercurrent in the opposite direction. Strong weather conditions in the area require a durable material for successful marine aquaculture. In former studies (Yigit et al., 2012; Yigit et al., 2013), copper-alloy nets have been used in offshore type HDPE cages in order to investigate the durability and strength of the copper alloy nets under strong farm conditions, with growth performance and feed utilization experiments on European seabass (*Dicentrarchus labrax*), gilthead seabream (*Sparus aurata*) and auxillary seabream (*Pagellus acarne*) stocked into copper alloy nettings deployed in a 2x2 bay grid in the Strait of Canakkale, Turkey. Outcomes from the previous studies, demonstrated promising results in terms of no organic growth on the copper alloy net material, better feed intake, feed utilization, and growth performance in fish grown in copper alloy net cage compared to those cultured in traditional nylon nettings. Overall the mesh openings were successful, and the open mesh without any bio-fouling improved water flow, which increased the oxygen

content in the water, which might have led to a high feed intake, hence a high SGR of fish. By underwater monitoring, it has been recorded that fish condition was well and no disease symptoms were available, possibly due to a more sanitary environment and reduced stressful conditions.

Environmental water quality measurements recorded at the Offshore Research and Development site in Canakkale, Turkey, have shown that copper alloy is an environment-friendly, and a promising alternative material for the traditional nylon nettings in cage aquaculture. However, this challenge of fish growth in copper alloy nettings has brought several concerns among consumers for food safety, in terms of leaching from cage material and their accumulating in fish body. In a previous study (Yigit et al., 2013), metal accumulation in body tissues of gilthead seabream (*Sparus aurata* Linnaeus, 1758) and auxillary seabream (*Pagellus acarne* Risso, 1827) in offshore cage systems with different net materials were investigated. Result of the research conducted by Yigit et al. (2013), findings of the tissue analyses in fish and mussels demonstrated that metal concentrations in the tissues of young seabream cultured to market size in copper alloy net cage, and in the muscle tissues of Mediterranean mussels around the cage system were below the regulatory limits for human consumption levels. This scientific approach with field work and advanced laboratory analyses demonstrated the beneficial effects of copper-alloy net material on fish and mussel tissues in terms of "Safe Food" production for the "Aquaculture Market".

Seabass and seabream are the two main species dominating Marine Aquaculture in the Mediterranean. Turkish and Greek Aquaculture Industries, with 332.896 tons of production (marine, fresh water and diadromous fishes), are in a rapid growth period among Mediterranean countries. The aquaculture production amount of the other main producers in the Mediterranean (Spain, Italy or Portugal) has been stable, while aquaculture production in France showed a serious decline during the last ten years (FAO Statistics-Figis, 2000-2014). Similar to seabream or seabass, the rainbow trout (*Oncorhynchus mykiss* W., 1792) is also an important pelagic fish species for the European and World Aquaculture industry. Due to the ion regulatory ability of rainbow trout, cage culture of this species in seawater has been in a rapid growth in recent years. Among European countries, Turkey with its production of around 212.805 tons of

rainbow trout is the 2nd biggest salmonid producer after Norway (FAO Statistics-Figis, 2014).

The consumer concern regarding metal accumulation in the fish body makes it worth to investigate the effects of copper alloy nettings on metal levels in the tissues of rainbow trout.

In the present study, feed utilization and growth performance of rainbow trout in both freshwater and seawater environment was investigated and compared in terms of environmental effects and life cycle assessments in offshore cage systems with copper alloy nettings. Furthermore, since fish farmers are challenging with problems of high feed costs, it is crucial to reduce any other costs that may influence the total production profit. The loss of fish during seawater acclimatization is one of the issues reducing the capital of the production. In this part of the study, the adaptation steps of rainbow trout starting from the transportation from freshwater hatchery to seawater and the acclimatization process have been observed. For this purpose, two different size groups of fish (mean weights of 35g and 22g) were transported and two different seawater acclimatization processes have been applied for each fish group, i.e., short and long term acclimatization, in order to evaluate the effects of fish size on transport and seawater acclimatization of rainbow trout with different adaptation procedures.

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TO WHOM IT MAY CONCERN

I hereby acknowledge that **Dr. Ümüt YIGIT** (ID: 68719155282) has been involved as a Researcher in the projects listed below, which were supported by International Copper Association (ICA-USA), and signed with Canakkale Onsekiz Mart University (Turkey).

Project 1:
Evaluation of Heavy Metal Contents in Various Tissues of Sea Bream Cultured to Market Size in Offshore Cage Systems with Copper Alloy Netting in the Northern Aegean Sea. "TEK-1049-20", FINAL REPORT November 2013. International Copper Association-USA. Joint Research and Development Project; Canakkale Onsekiz Mart University & University of New Hampshire, USA.

Project 2:
"Comparison of Growth Performance and Feed Utilization of Rainbow trout (*Oncorhynchus mykiss*, W., 1792) in Freshwater and Seawater with Environmental Effects for Life Cycle Assessment in Offshore Cage Systems with Copper Alloy Netting in the Northern Aegean Sea". "ICA PROJECT NO. ENV- 25686 A-12 (2013)", FINAL REPORT November 2014. Canakkale University Copper Alloy Demonstration Farm. Joint Research and Development Project; Canakkale Onsekiz Mart University & University of New Hampshire, USA.

This document has been prepared and signed upon request of Dr. Ümüt YIGIT.

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