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Seaweed cultivation laboratory testing: effects of nutrients on growth rate of *Ulva intestinalis*

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Abstract

New seaweed cultivation laboratory was developed and primary laboratory bench was tested if the conditions are relevant for seaweed cultivation. Simple experiment was carried out using *Ulva intestinalis* as test organism. Different nutrient levels were provided to see, which amount of nutrient is the best for cultivation of U. intestinalis. Experiment results showed that best growth rate for *Ulva intestinalis* was on concentration 2 ml L^{-1} where growth rate reached on average 7.13 ± 3.44 % per day. Higher nutrient amounts slow down algae growth.

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Keywords: macroalgae; cultivation; in vitro; *Ulva intestinalis*; Baltic Sea

1. Introduction

Energy demand has rapidly grown since the beginning of the Industrial Revolution and it is still increasing at a rapid pace [1]. In 2009 it was estimated that 86 % of world energy consumption is derived from fossil fuels such as oil, coal and gas. Furthermore, increasing population will increase demand of fossil fuels by 20 % in the next 20 years if a new cost effective and viable energy source is not found [2]. Excessive use of fossil fuels has a negative effect on both the environment and the economy. Overuse of fossil fuels leads to enormous amount of greenhouse gas emissions

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which contribute to global warming, rising sea levels and many other concerns such as loss of biodiversity or receding of glaciers. All of these factors contribute to the need for an alternative, sustainable, effective, cost effective and cleaner energy resource that would be able to meet future demand and needs [3–7].

Macroalgae are macroscopic multicellular organisms that, depending on their pigmentation, are divided into three groups: brown, red and green algae. While most of the species live in seawater, some species are found in freshwater as well. Macroalgae found in seawater are called seaweeds [8, 9]. Usually they are present near to the shore where they are attached to different types of substrates. Both microalgae and macroalgae are considered to be a third generation energy resource and scientists hope that this kind of bio energy will overcome imperfections of previous generations of bio energy [10, 11].

Bio energy is an excellent alternative to the traditional fossil fuels because instead of using gas, oil or coal to produce energy, for bio energy production a renewable resource – biomass is used. During the process of seaweed growth, light energy and CO_2 is absorbed to produce organic molecules such as carbohydrates and lipids. These molecules can then be used to produce a different kind of fuel [12, 13]. Seaweed cultivation is attractive with the fact that it does not require arable land and in the production process freshwater is not used so it does not compete with traditional crops. Cultivation process does not accelerate ongoing climate changes in any way because algae can absorb atmospheric CO_2. Furthermore, seaweed grow and multiply rapidly and their containing polysaccharides makes seaweed attractive not only for biofuel and biogas production, but for food, animal feed and various substance production [1, 3].

Seaweed use in Latvia is limited. Algae beds in the sea are protected, but washed out seaweed called “seawaste” are taken to landfill. Although due to the low salinity the size and biomass of seaweeds is not that big as in the southern Baltic Sea, seaweed biomass could give major input. The most effective way to increase available seaweed biomass would be to develop off shore seaweed cultivation systems. Seaweed consume various nutrients found in seawater and in such way cleans seawater and even could be a way to reduce eutrophication level in the Baltic Sea [14].

Since seaweed are sedentary organisms, they need to be resistant to a variety of physical conditions such as salinity, temperature, light intensity, water motion, nutrient level and CO_2 concentrations. For optimal growth, all of these factors should be in a certain, usually very narrow, range. For each of the species this range can vary so it is crucial to determine the best conditions for each species [3]. Although for many highly popular seaweed species all of these factors are studied and explored [15], studies on Latvian conditions are still scarce. One of the things that has to be done before starting seaweed cultivation for bio energy production, is to explore optimal growth conditions for the most popular seaweed species in Latvia *Ulva intestinalis*, *Furcellaria lumbricalis, Fucus vesiculosus* [7]. Seaweed cultivation laboratory is essential to prepare seeding material and identify the best parameters for algae growth in a laboratory environment. One of the most important parameters is nutrient level so the simple nutrient test was carried out to test seaweed cultivation laboratory using green seaweed *Ulva intestinalis* as a test organism.

2. Materials and Methods

Before building up the laboratory bench for seaweed cultivation, available literature was explored and the most essential parameters were identified and a lab scheme was developed (Fig. 1).