On The Road to Recovery of Organic Waste into a Growth Substrate - Öland Case Study

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Abstract. The CONTRA- Baltic Beach Wrack- Conversion of Nuisance to a Resource and Asset project aims to transform Beach Wrack into a Resource. In collaboration with CONTRA project, the Environmental Science and Engineering Group (ESEG) aims to demonstrate the technological and economic feasibility of using beach wrack raw materials for energy production and bio-based compost as practical approaches towards the circular economy. In the present study, the purpose is to concentrate the nutrients from four different biological materials (beach wrack, sawdust or wood chips, degraded sediments and Coffee powder), through the composting process.

1 Introduction

Beach wrack accumulations on beaches and along coasts have recently gained much attention worldwide due to its influence on the society, environment, economy and economy. Beach wrack is an organic material consisting from old sea-grass biomass, various other marine organisms, as well as manmade litter, which accumulates on beaches due to the action of waves, tides and aperiodic water level fluctuations [17, 10]. Beach wrack offers many ecosystem services and a link between the marine and terrestrial environments. It provides habitat (food, nesting, and shelter) to important animal communities including invertebrates and shorebirds that inhabit shorelines and contributes to the coastal and marine food web systems though supplying essential nutrients as the organic material decomposes and breaks down [7, 5, 14, 13]. In spite to the natural origin of the majority of this material and its significant ecological role, sea wrack become a social amenity and/or environmental issue, if accumulated in excessive amounts [7, 11, 5, 14, 4, 13, 10]. Moreover, marine eutrophication and climate change not only affect the accumulation of sea wrack but may be affected by the products of its aerobic decomposition as well. It is estimated that the annual global carbon flux from seagrass wrack to atmosphere ranges from 1.31 to 19.04 Tg C yr-1 [9]. In addition, the material accumulated on the seashore decomposes quickly, which is accompanied by a troublesome odour that keeps tourists away [8]. It is therefore both an ecological problem for the eutrophicated reservoirs and the social one associated with nuisance for inhabitants and tourists visiting seaside resorts [8]. The main assumption of this project is that the beach waste constituting a nuisance should be turned into a source that brings benefits. Gathering,
storing, transporting and processing of beach wrack material is an essential issue in waste management. The collection and recycling of the beach wrack are usually performed as a part of a municipality’s management system or by the camping owners. Once these actions are done, the marine biomass is managed as urban solid waste and ends either in landfills or incinerated.

Beach wrack prevention, management, and utilization have attracted considerable attention at international level, as beach wrack has been globally distributed and is in Sweden classified as a waste when you start to handle it but for use as fertilizer. Poor management of beach wrack waste has negatively impacted on the global economy, society, and environment. All this has progressively led to the awareness that more systematic approaches to beach wrack management which might be useful in the circular economy.

Composting and fertilizer technologies have increasingly used renewable resources where the European Commission has set a goal for 30% reduction of non-renewable resources in fertilizer production as the amount of waste discarded into the environment increases [16]. The use of biological waste is practically based on the recovery of materials, introduced by the European Commission as a response to issues of global environmental threats [15].

The present research aims to establish a model for the management of beach wrack residuals in dorm beaches and marinas providing alternative and more environmentally friendly options of the utilization of the material. Additionally, the project contributes to a possible solution of social concerns and negative touristic impacts of beach wrack accumulation in coastal areas and mainly in sandy beaches.

2 Pilot case study

2.1 Material and Methods

Marine macro algae were collected from the Wikegård Semesterby & Ställplats-Camping in Öland (57°04′43.9″N 16°58′22.5″E), Sweden in June 2020 and transported at the facilities of Linnaeus University, Kalmar Sweden. (Figure 1).

Five compost piles were set up in a pallet collars of manufactured size L1200 x B 800 x H 200mm at the facilities of the Linnaeus University at Kalmar, Sweden. (Figure 1):

- 50% beach wrack mixture, 50% green residual (25% wood dust + 25% coffee powder).
- 80% beach wrack mixture, 20% green residuals (10% wood pallets + 10% coffee powder)
- 70% beach wrack mixture, 15% sediments, 15% green residuals (7.5% wood dust + 7.5% coffee powder)
- 50% beach wrack mixture, 50% sediments
- 30% beach wrack mixture, 40% sediments, 10% green residuals (5% wood dust + 5% coffee powder)
Fig. 1. Wikegård Semesterby & Ställplats-Camping in Öland (photos by William Hogland, June 2020).

Fig. 2. Installed composters and internal mage of composter material (photos by Varvara Sachpazidou, June 2020).
2.2 Sampling and Analysis

The process will be carried out as aerobic purely biological fermentation of the mixture, without any chemical addition or treatment, so the generation of microorganisms inciting the biological composting process and assist the decomposition process. That process will lead to the release of the nutritional components.

Regularly, during the experiment, the parameters which should be controlled are: temperature (3 x per week), Volatile solids (VS) [3], the percentage of nitrogen and phosphorus, total organic carbon (TOC) [12], total Kjeldahl nitrogen (TKN) [6], the ratio of nutrients carbon to nitrogen (C/N)-will be calculated from the results of TOC and TKN analysis, pH [1] and electrical conductivity [2]. Physiochemical and microbiological parameters will be also determined at external labs in Sweden.

3 Drawing conclusions

The production of this fertilizer will be low cost and this will significantly reduce the costs of production of agricultural and vegetable products. An eco-friendly product will improve the quality and the protection of the environment. Additionally, many research studies have been reported that algae have the ability to bind metals either on the cell surface or in the inside of the cells, helping them forming complex formation to neutralize the toxic effect of heavy metals.

The mission of the present study is to provide a wealth of possibilities that beach wrack can lead to new materials, in line with the principles of bio-economy and circular economy. Some of the drawing conclusions are:

- Pretreatment is increasingly important for beach wrack digestion process as the surface salt and sand removal is mandatory.
- Composting of beach wrack is an optimal method for minimizing the impact of managing tourist beaches. By knowing the quantities and areas where beach wrack is washed up in large amounts, it is possible to place composting unit facilities, in order to use optimal transport routes.
- Composting is the main waste recovery method on which many countries still rely.
- Composting is an economical method of waste management.
- It is necessary to fully record the waste generated. The rational waste management starts with the correct knowledge of the quantities and areas of waste.
- Along with composting, sorting systems must be developed in source that will improve the conditions for the separate recovery of as much waste material as possible.
- Research of all available materials of plant biomass and bio-waste for waste rational management.
- Modernization of existing waste treatment facilities.
- Possibilities for further study of other species of plant biomass to make use of it through composting, for greater improvement of the method and conditions as well as the compost produced and its benefits.

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