IMPROVEMENT OF BEACHED Posidonia RESIDUES PERFORMANCE TO COMPOSTING

Extended abstract

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Background

Posidonia oceanica (L.) Del. is a marine monocotyledon endemic of the Mediterranean. The plant can produce up to 10 t·ha⁻¹·year⁻¹ of biomass (in terms of dry weight), which in part (about 25%) is accumulated along the coast in the form of beached residues (leaves and fibers), often in characteristic piles ("banquette").

Accumulations could be huge: an investigation carried out in the framework of Life+ PRIME project, showed that in the coastal site of Mola di Bari (Bari, Italy), as an example, in August 2011 were found approximately 8,800 m³ of posidonia residues in an area of about 7,400 m², while in a stretch of coast approximately 600 m long and 4-5 m wide, in Torre Canne (Fasano, Italy), were measured in the period from August to October 2011 about 2,600 m³ of residues. The presence of such huge biomass along of the coast represents a complex problem for the coastal municipalities when the accumulation interferes with economic and recreational activities, first of all the touristic use of beaches. The presence of high amounts of residues close to urban centers may also represent a hardship because of the odors that develop from the accumulation, or even a danger because of the possibility of fires, with consequent problems of public health and safety. In all these cases, the coastal municipalities are forced to remove seagrass residues that, in the absence of alternative solutions, are disposed of in landfills resulting in both environmental charges, due to the significant amount of organic matter removed from the ecosystem, and economic due to disposal costs. In Italy the possibility of using the sea grass as a raw material for composting is fairly recent. With the Legislative Decree no. 75 of 29 April 2010, this material is allowed in the composition of the mixtures, although at a maximum of 20% by weight (Decreto Legislativo, 2010). Currently, however, the use in industrial composting is rather limited, despite the good attitude of the material for this use (Cocozza et al., 2011a, b). The major concerns are represented by the excessive presence of sand and the high concentration of salts (mainly sodium chloride) that the residues may contain. The collection phase, therefore, represents a critical step for the beached biomass management.

The methods used during the beach cleaning and seagrass residues removal have repercussions both on the environmental impact related to the intervention and on the possibility of reuse of the collected biomass. Indeed, the presence of extraneous components within such organic material (in particular the sandy sediment) can affect the acceptability of the biomass in the composting industry. The separation of the sandy sediment from posidonia residues is relatively difficult because the sand is often intimately interconnected with organic fraction. In a survey conducted in the PRIME project, has been found that 1 m³ of sea grass residues can hold up to 150 kg of sand.

Moreover, the high salt content of the residues may lessen the attitude to composting for the influence it could have on the final compost properties (Lopez et al., 2011). The objectives of the present research were: i) to test different treatments to separate sand from posidonia beached residues and reduce the salinity of the material, with the aim to improve its attitude to composting; ii) to study the effects of those treatments on final properties of compost.

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Methods

1. Sand separation test

This operation was mechanized by means of a prototype (“Rotative Sieve”), realized by the partner of PRIME project Tecoma Drying Technology srl (Maranello-MO, Italy), consisting of a tank equipped with a stirrer and a movable cylindrical sieve with 2 mm holes. The principle of operation of the prototype for the separation of the sand consists in washing the residues with sea water and in subsequent sieving. The operation is conducted in two phases. In the first, residues of Posidonia are placed inside the tank containing the water, where, by means of a movable arm, the washing of residues takes place. Subsequently, the residues are run inside a movable cylindrical rotative sieve which completes the separation. Three duration of the treatment have been tested: 15+15, 10+10 and 5+5 minutes for the first and the second phase, respectively. In order to quantify the sand present in the material before and after the separation treatment, 3 samples (replications) were taken from each type of material. Samples were placed in containers of volume 1.25 L, standardizing the filling by the application of a constant pressure of 7.5 g·cm⁻². Subsequently, the residues were separated from the sediment by wet sieving with a 2 mm sieve. After sieving, both the oversize and the undersize fraction (respectively, > 2 mm consisting of leaves, and <2mm consisting mainly of sandy sediment and a small part of posidonia fibers) were dried at 105 °C. In order to completely separate the organic fraction from the sediment, the undersize fraction was treated with H₂O₂ 130 vol. at a temperature of 40 °C (ANPA, 2001). At the end of the oxidation (indicated by the stop of effervescence), the residues were repeatedly washed in running water, dried again in the oven and finally weighed.

2. Salinity reduction test

The possibility of reducing the salinity of the residues by storing the material under the action of rain was tested. The test involved the study of! leaching from the stored material in relation to the time of storage and the amount of water distributed. About 140 m³ of beached posidonia residues, manually collected on the coast of Mola di Bari (BA), were stored on July 27-2012 at the Experimental Farm La Noria of CNR-ISPA, in a pile of height 1-1.5 m, 8 m wide and 14 m long. During the period of storage, rainfall events were simulated, by means of water distribution devices with low intensity (20.6 mm·h⁻¹). Daily distributions of 60 minutes with well water (pH 7.2, conductivity 5.5 dS·m⁻¹) were provided. All the material was turned weekly in order to avoid putrefactive phenomena. During the test, the quantities of water distributed have been recorded; leaching fraction has been measured and leachate has been sampled at every overturning of the material, by four sampling points inside the mass by means of special collection tanks. Electrical conductivity (EC), pH and the content of potassium (K), magnesium (Mg), sodium (Na) and chlorine (Cl) have been measured on leachate samples by means of ion chromatography ( Dionex DX 120, Dionex Corporation, CA).

3. Compost production test

With the objective to test the influence of sand separation from Posidonia residues on their attitude to composting, two Posidonia -based green compost (GW) were produced at the experimental farm “La Noria”. Two piles (each approx. 3 m³) of Posidonia leaf residues, collected along Mola di Bari (BA) coast, mixed with tomato plant residues and olive tree pruning residues, were generated.

In the first compost, here referred as “GW Treat”, Posidonia residues treated with the prototype “rotative sieve” to separate residues from sand were used; in the second compost, here referred as “GW NoTreat”, posidonia residues just collected from the beach and not treated with the prototype were used. The two composting mixtures were produced using the following proportions of raw materials (on a % fresh weight basis): posidonia residues, pretreated or not-pretreated, (20%) + tomato plant residues (40%) + olive tree pruning residues (40%). The proportion of raw materials in the mixtures were designed to obtain a C:N ratio of 35-45, which is considered optimal for microbial growth (Michel et al., 1996; Kumar et al., 2010). The composting cycle started on July 19th 2012. The temperature of the piles was kept ≥55 °C for at least 3 days and then controlled by turning and irrigating the piles to obtain the pasteurization of the biomasses. The active phase of the biomass was considered completed after approximately 4 weeks, when the temperature of the piles decreased to values of 40-50 °C.

The curing phase was characterized by less frequent turning and continued until the 90th day to achieve further stabilization and obtain the final products. With the objective to test the influence of salinity reduction on the attitude to composting, residues of Posidonia subjected to storage and residues just removed from the coast were transferred to an industrial composting plant (ASECO srl, Ginosa-Ta, partner of PRIME project) and mixed (16-17% on a weight basis) with sewage sludge (28%) or organic fraction of urban solid waste (29%) in factorial combination. In all mixtures, to maintain the C/N ratio in the optimal range, wood, plant debris and food scraps (16-17%) were added. Four Posidonia-based compost were obtained: 1) with stored residues and sewage sludge (CSS PSt), 2) with stored residues and organic fraction of urban solid waste (CMSV PSt), 3) with not stored residues and sewage sludge (CSS PNoSt) and 4) with not stored residues and organic fraction of urban solid waste (CMSV PNoSt). The mixtures were placed inside biocells in piles of 4 m wide and 2 m high. The oxygenation was assured by forced ventilation system. The composting process took place from September 2012 to January 2013. On obtained compost, EC, pH, ash content (by combustion in a muffle a 550 °C), concentration of Na (by ion chromatography) in water soluble extract and heavy metal concentration (by OES ICP), have been determined.
Results and discussion

1. Sand separation test

Table 1 shows the sand content in the starting material used for the tests and in the one treated with the prototype, in function of the duration of treatment. The data indicate that the content of sandy sediment in posidonia residues undergoes an almost total abatement following the treatment, while the washing time does not significantly affect the fraction of the sediment removed. The almost total abatement of the sand obtained with the “Rotative Sieve”, is also reflected on the density of the material that, due to the loss of sediment, is significantly reduced compared to the starting material, despite the increase of moisture resulting from the washing, inconvenience the latter that can be solved by providing, after the treatment, an on-site storage for a variable period of time depending on the climate conditions.

<table>
<thead>
<tr>
<th>Duration of Treatment</th>
<th>Density (kg/m³)</th>
<th>Content of Sand (kg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starting material</td>
<td>426 a</td>
<td>153.2 a</td>
</tr>
<tr>
<td>15 + 15 min</td>
<td>268 c</td>
<td>0.37 b</td>
</tr>
<tr>
<td>10 + 10 min</td>
<td>281 bc</td>
<td>0.09 b</td>
</tr>
<tr>
<td>5 + 5 min</td>
<td>304 b</td>
<td>0.39 b</td>
</tr>
</tbody>
</table>

Significance: ***

*Data are means of three replications. Mean separation within columns by LSD0.05. *** significant at P≤0.001.

2. Salinity reduction test

The exposure of Posidonia residues to water wash-out, by simulating a daily rainfall, made it possible to substantially reduce the presence of salts in the material. The EC measured in water drainage, which was on average 16% of the water distributed, in fact, has been gradually reduced over time from 55 to 7 dS·m⁻¹ after 60 days (end of the storage period) (Fig. 1a). It can also be deduced that, in the conditions of the test, the duration of the storage period could have been reduced by one or two weeks since the EC variations of the last weeks were very small. Parallel with the reduction of EC, it was reduced the concentration of major inorganic ions in water drainage; in particular, the Na and Cl, present in high quantities in the first weeks, have declined steadily during the test (Fig. 1b), demonstrating the ease with which they can be removed from the material. Similar trends have also presented other ions whose concentration values, however, have stabilized earlier than the previous two. The removal of the salts in the water drainage has led to the consequent reduction of EC in the material that decreased from 9.4 to 0.6 dS·m⁻¹ at the end of the period (Fig. 1c). The action of run-off has considerably altered the chemical composition of the aqueous extract of the stored material. In particular, Na, Cl, Mg and K were reduced by 71, 45, 23 and 62%, respectively (Fig. 1d). These results indicate the opportunity to reduce the salinity of Posidonia residues through the temporary storage and exposure to the washing action of the rain, selecting appropriate period and seasons. Furthermore, it is preferable to select the storage site in areas very close to the coast, in order to avoid phenomena of salinization or contamination of the groundwater with the salts removed from the stored material.

3. Compost production test

The EC, while not representing a parameter subject to limits by regulations, is essential for the agronomic evaluation of compost. Among the compost obtained, the EC was low in the two GW compared to other composts (Fig. 2). Using posidonia residues stored as raw material, the EC was reduced by almost 30% compared to when using not stored material, highlighting the effectiveness of an appropriate period of storage that guarantees at least the partial removal of the salts. The ash content was lower in GW compared to other composts and in particular in GW Treat with respect to GW NoTreat: that confirms the importance of removing the sand from the material before starting composting (Fig. 2). The concentration of Na in the compost obtained from posidonia residues subjected to storage was markedly lower than those just collected for the aforementioned effect of washout. Instead, the
differences of EC found between the two GW are due to the process of separation from the sand that, using sea water, involves a partial enrichment in salt (Fig. 2).

From the point of view of the dangers related to heavy metals presence, all compost products have presented concentrations of heavy metals (in particular lead, cadmium, nickel, zinc, copper and mercury) well below the limits set by the Italian regulations (D. L. 75/2010) (data not shown), therefore the use of such compost products can be considered safe. Some of the Posidonia based composts described above have been used in cultivation trials of green bean and lettuce as soilless growing media component in replacement, partial or total, of peat. For the green bean were used, in comparison with peat alone used as a control, CMSW PSt, CSS PSt and GW Treat, alone and in mixture with peat (50:50 by volume). The substrates were placed in of 10 L volume pots. Plants grown in mixtures showed same yield than those grown in peat alone (547 g of commercial product per plant) while the compost used alone reduced yield of approximately 50% (432 g of commercial product per plant). For the cultivation of lettuce was used only the CMSV PSt in mixture with peat at 25, 50, 75% in volume, as well as alone.

Even in this case peat alone was used as a control. In this test, when used in the mixture compost allowed a higher plant growth which resulted in higher yield of almost 30% compared to the control (470 vs 369 g fresh weight/plant, respectively), while when used alone the production was lower but still greater than the peat alone (430 vs 369 g fresh weight per plant, respectively).

![Fig. 2](image-url). Electrical conductivity (EC), pH, ash and content of Na in the aqueous extract of six posidonia-based compost. Vertical bars represent ± SE of mean (n=3).

**Concluding remarks**

The residues of beached Posidonia are often perceived as a waste. The experiences described in this research show that they can be turned into a resource for agriculture through the composting process, using proper preliminary treatments to increase their attitude to composting.

**Keywords**: compost, salinity, sand content, seagrass

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**References**


