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Evaluation of a new technology for increasing the quality of a compost

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Abstract: Composting is a treatment process that transforms biodegradable organic waste into compost, a product rich in essential nutrients used as a fertilizer, an advantageous procedure with a good impact on the environment.
In collaboration with the companies G.A.I.A. S.p.A (compost producer) and TOSO S.r.l. (conveyor producer), the following actions were decided to improve the compost treatment process in its final refining step. where, three fraction are produced: > 50 mm (containing plastic films and paper), <12 mm (stocked for market), and < 50 mm > 12 mm This last fraction is used as inoculum because rich in bacteria for organic biodegradation but it still contains a significant amount of plastic film, which thanks to the recirculation as inoculum continues to remain in the process.
To propose a plant solution, this compost fraction was characterized and the efficiency of a deplasticizer machine equipped by a conveyor belt, beater rollers and aspirator was analysed. The fine clean material falls through the mesh, and it is separated from the coarse impure material. The results thus obtained were satisfactory with the recovery of more than 10% of the of fine clean compost and very low percentages of unwanted substances.

Keywords: organic, compost, impurities, conveyor belt, aspiration

1. Introduction

The modern lifestyle has contributed to increase the production of urban solid waste. This increase in waste generation requires the implementation of an efficient waste management system, in a way to increase its recycling and reuse (Gundupalli et al., 2017). The organic fraction, mainly from domestic wastes, corresponds to a significant portion of the generated waste, and when transformed in compost could be recycled and used as fertilizer (Sayara et al., 2020).

The process named composting refers to biodegradable transformation of organic waste into a product rich in essential nutrients (nitrogen, phosphorous and potassium) (Sayara et al., 2020). Since it is characterized by a high organic matter content as well as abundance in macro- and micronutrients, it can be used as a fertilizer for the cultivation of agricultural land (Zhao et al., 2013). By decreasing landfill disposal and avoiding incineration, this procedure is advantageous, and it has a good impact on the environment (Pace et al., 2018). Nevertheless, in the organic domestic waste it is still find non-compostable plastics, making this mixed residual being complex and a challenge for recycling (Horodytska et al., 2020).

In the GAIA treatment scheme for the production of compost, a critical issue has been identified that needs a solution: during the final refining process, the compost, which has already passed all the maturation stages, is screened at 12 mm with a drum sieve. In this way, the compost ready for the market is obtained. The oversize > 12 mm of this separation is sent via conveyor belt to a star disc screen with an opening of 50 mm. The product > 50 mm is actually made up of plastic films and paper and is disposed of, the product < 50 mm and > 12 mm (overflow) is used as inoculum as it is rich in bacteria useful for starting biodegradation organic, but still contains a significant amount of plastic film, which thanks to the recirculation as inoculum continues to remain in the process. The first step of the research was therefore a granulometric and compositional characterization of this specific fraction, the over flow, part of the GAIA production.

TOSO S.r.l., on the base of the overflow characterization started the design and construction of a machine capable of removing plastics from organic, improving the quality of the final product. Tests to evaluate the design and to evaluate the efficiency of the deplasticizer machine were performed on different prototypes.

This research aims to increase the quality and therefore the value of the compost of the plant produced by GAIA S.p.A. improving the quality of the mature compost produced, separating impurities from the final product to improve its quality.

The DIATI working group, made up of Rossana Bellopede, Camila Mori De Oliveira, Oliviero Baietto, Andrea Sammito and Paola Marini in the context of the

SiComposta Project, on the basis of the characterization carried out of the waste leaving the disc sieve of the refining line of compost by Gaia, contributed to the formulation of a design hypothesis of a deplasticizer machine. Subsequently he was involved in sampling the products coming out of this machine in the successive phases of its development.

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2. Material and methods

In the treatment scheme for the production of compost, a critical issue has been identified that needs a solution: during the final refining process, the compost, which has already passed all the stages of maturation, is screened at 12 mm with a drum screen. In this way, the compost ready for the market is obtained.

The > 12 mm of this separation is sent via conveyor belt to a star disc screen with an opening of 50 mm (Figure 1).

The product > 50 mm made up of plastic films and paper and is disposed of, the product < 50 mm and > 12 mm (overflow) is used as inoculum as it is rich in bacteria useful for starting biodegradation organic, but still contains a significant amount of plastic film, which, due to the recirculation as inoculum, continues to remain in the process.

In order to improve the characteristics of the overflow, the following actions were decided:

- granulometric and product characterization of the surplus
- plant solutions of a deplasticizer machine prototype
- tests with deplasticizer machine prototype and characterization of the products obtained

3. Results

The results of the granulometric and compositional characterization of the >12 mm and < 50 mm fraction in the initial condition are reported in Figure 2 a and b Observing the graph shown in Figure 2a), it can be seen that the analyzed samples mainly contain, in mass, organic material (69%), light and heavy plastic (around 3% and 2% by mass), paper (about 10%), glass (4%), stones and other substances in smaller quantities such as tiles, shells, etc

From the graphic representation of the granulometric curve (Figure 2b) it can be highlighted that about 70% of the sample has a size of smaller than 12 mm.

The consequence of these results is the apparently simple idea of reproducing, through the use of a metal mesh conveyor belt, the operating conditions and the results obtained through the use of a sieving machine to break up the material and better separate all the elements, and of adding over the final side of the conveyor where the material stat to fall an aspirator collecting the plastic films now lightened by the compost particles that made its suction difficult.

The plant design will consist in adding, downstream of the disc screen already present in the G.A.I.A refining line, a mesh conveyor belt to recover all the fines which will be added to the compost < 12 mm exiting the drum screen; after which the coarser material (i.e. with a real diameter >12 mm and < 50 mm) passes under a suction separator, with the aim of separating the plastic definitively and recovering all the organic material with a size greater than that of the belt mesh screens.

Figure 3 represents the results of the granulometric and compositional characterization of the >12 mm and < 50 mm fraction after the passage through the new deplasticizier conveyor belt.

a)

b)

Figure 1. a) Final compost < 12 mm exiting the trommel screen**. b)** Star or disc screen with 50 mm opening

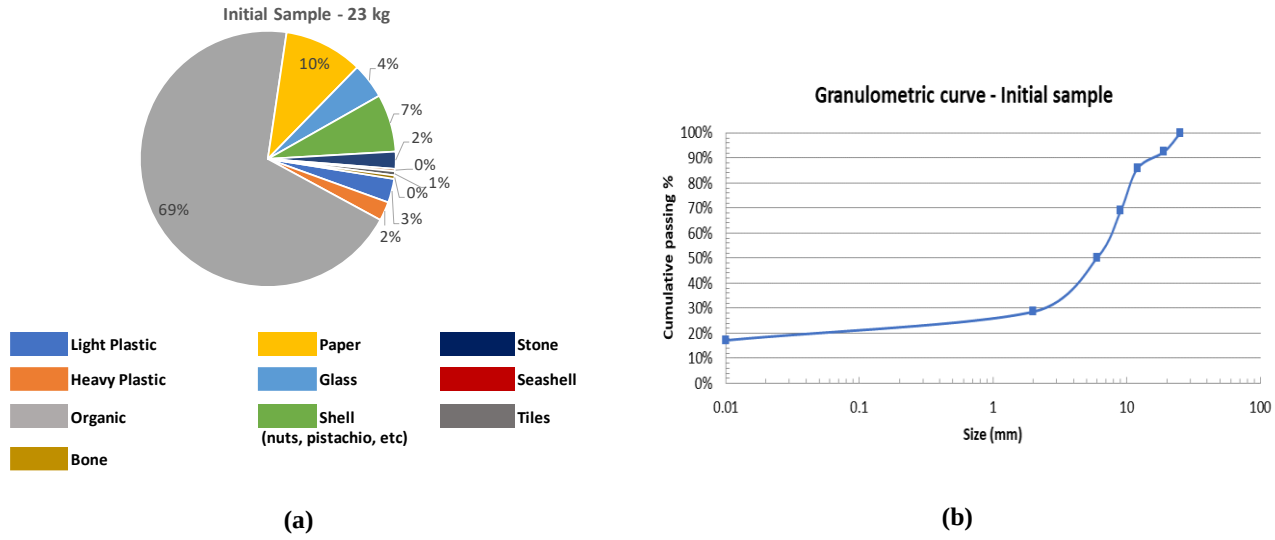

Figure 2. Percentage composition of the initial sample (a) and granulometric curve (b)

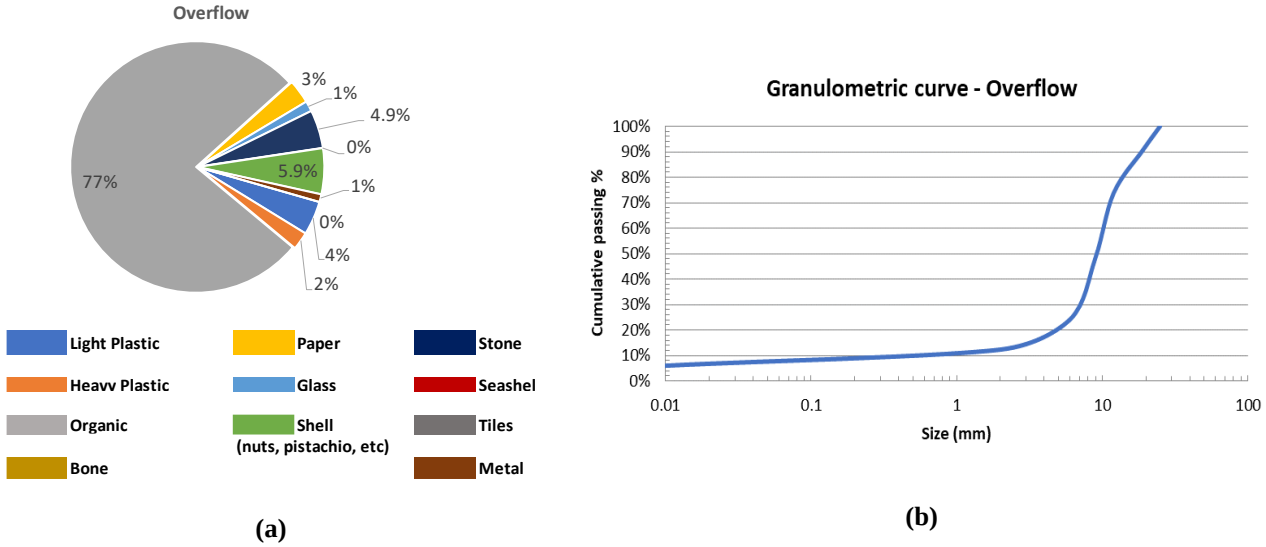

Figure 3. Percentage composition of the overflow sample (a) and granulometric curve (b) resulting from the prototyped mesh conveyour with aspirator.

4. Conclusions

The goal of the entire project is the design and construction of a deplasticizer machine to be inserted into the compost refining line, to optimize the process for the purpose of obtaining a quality product, with the consequent reduction of waste to be disposed of at the landfill.

The final machine proposed consists in a mesh conveyor belt, with beater rollers capable of making the mesh "jump". The fine material falls through the mesh, and it is separated of the coarse impure material. The results thus obtained were satisfactory with the recovery of more than 50% of fine clean compost and a reduction of 75% of plastic film.

Through the modifications designed by TOSO to implement and improve the refining line of the GAIA plant, it should be possible to solve the problems on which the project is focused, consequently allowing the company to have, downstream of their post-treatment, a clean compost that respects the parameters set out in the current decree on fertilizers (Legislative Decree 217/06); using this combination of machinery.

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