
Baltic
MUPPETS

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Report on the hygienization process

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1. WASTE MUSSELS AND ANIMAL BY-PRODUCTS REGULATION

Animal by-products (ABP), here defined as dead animals and body parts involved in commercial activities that are not intended for human consumption, can be considered a potential source of risks to public and animal health. ABP also include aquatic animals, meaning that both feed mussels (=mussels harvested with intention to use as animal feed) and waste mussels must be treated in accordance with the health rules laid down in EUs ABP-regulation (EC) No 1069/2009. The process currently used by Ecopelag AB for feed production requires live mussels. As the first process step through pressure cooking, resulting ABPs are hygenized and no longer considered a risk. Therefore, the subject of this report will not be focused on feed mussels, but rather on our planned treatment of waste mussels. Waste are here defined as harvested mussels that for some reason did not pass through the production line (Fig.1).

Dead mussels are classified as ABP category 3 (lowest risk-class). There are several different options for hygenisation and use of category 3 material, but we have focused on option (f) stipulated under Article 14 in EC No 1060/2009, 'in the case of material originating from aquatic animals, ensiled, composted or transformed into biogas'. Approved methods for hygienisation of Category 3 materials are specified in chapter III of (EU) No 142/2011, which is the regulation on how to implement (EC) No 1069/2009. We chose to work with method no 7, ”Any processing method authorised by the competent authority where the following [specified further in text] have been demonstrated by the operator to that authority”.

Fig 1. Mussels on quay outside of the Baltic Sea Factory

2. PREPARATORY WORK – PROJECT 'SMALL MUSSELS WITH BIG VALUE IN TROSA MUNICIPALITY' [1]

2.1 The method

In a project foregoing Baltic Muppets, Ecopelag EF studied processing methods that had earlier been approved by the Swedish agricultural agency for treatment according to (EU) No 142/2011 Chapter III. With aim to find a processing method that would be locally available, fit for smaller volumes, environmentally friendly and that would enable production of future marketable products, attention fell on the drum compost method. Two cases described in a report from 2015 featured rotating drums where ABP (manure) was composted together with food waste during temperature monitoring. Heat was emitted by microorganisms during the process, and the results showed that heating of the material to more than 52°C for at least 13 hours would kill the types of bacteria that pose a risk to public and human health according to the(EC) No 1069/2009 regulation. Rotation of the mix made sure that heat was evenly spread throughout the material, and after a batch was finished, the result manure or compost could be sold commercially (Fig. 2).

Fig 2. A compost method approved for hygenization of ABP, according to JTI report Lantbruk & Industri/ Agriculture & Industry, nr 427

2.2.1 Suggestion from Västervik municipality

When planning for waste management at the Baltic Sea Factory in Västervik, Västerviks municipality scanned for local options that could, and would, handle waste mussels. Facilities approved for treatment of commercial ABPs are scarce, apart from biogas plants that are hesitant to try new substrates (especially if small volumes). Farmers often have suitable facilities for the treatment of ABPs, but will mostly treat their own manure and can do so without using any of hygenization methods stipulated in (EU) No 142/2011, as long as the competent authority does not consider it to present a risk for the spread of any serious

[1] Swedish title ”Små musslor med stort värde, Trosa kommun”. A local water management (LOVA) project inanced by Södermanlands County board.

transmissible disease. Hence, they often lack the necessary registration and permits needed to treat and dispose other than their own materials.

The Västerviks municipality developed the idea to mimic the drum compost process on a farm, using an animal feed mixer. Here, the substrates would compost while mixing in a sealed container (Fig. 3).

Fig. 3. A feed mixer (this model is Kongskilde VM volume16 m^3) with two internal screws for grinding and mixing. This type of agricultural machines is readily available.

2.2.2 Discussion with the Swedish agricultural agency

The next step was to contact the Swedish Agricultural agency, the competent authority for handling ABPs in Sweden. They were generally positive to the idea, and came to Västervik on May 8th 2023 to inspect the feed mixer and inform us about the necessary conditions for a permit. A critical point needed for permitting of our suggested method was to have temperature monitoring installed in all representative "corners" of the mixer: Front surface, front bottom, back surface, and back bottom, to make sure that all material in the mixer reached the critical temperature of >52°C for at least 13 hours before the hygienization process was terminated.

2.2 The compost recipes

As part of the project in Trosa municipality[2], the company Biocompost AB was contracted for analyses and to help us with compost recipes. The success of a rapid compost, in our case defined as a fast temperature rise, is determined by several parameters. Some of those are easy to measure and adjust, such as moisture content, C/N ratio and particle size. Based on measured properties of our spill mussels and a small-scale experiment, Biocompost

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suggested potential compost recipes for mussels that can be further used in the context of treating spill mussels from the Baltic Sea factory (Fig. 4).

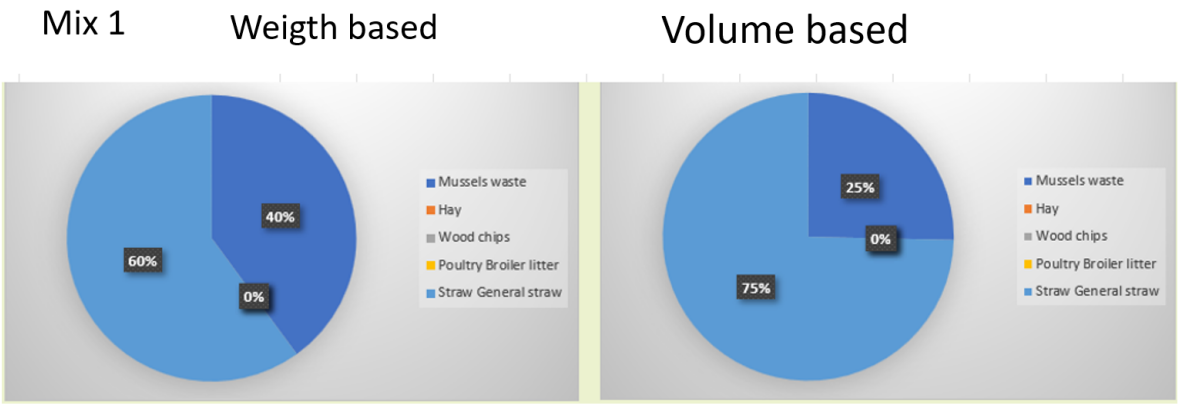


Fig. 4. One of the suggested recipes for mussel compost used as model for further evaluation. This recipe was chosen based on access to the necessary materials.

3. BALTIC MUPPETS - THE PERMIT APPLICATION

3.1 Preparation of the application documents

Ecopelag contracted a local company, Johan Djerf's agriculture and forestry, for the implementation of the compost experiment, including renting of the feed mixer. Hence, the permit application was submitted in the name of the contractor.

The permit application contained 4 documents:

1. Registration of the company as plant for handling of animal by-products
2. Application for the receiving of animal by-products for other purpose than feed
3. A description of the process
4. A flow schedule of the process, including critical control points (Figs. 5 and 6)

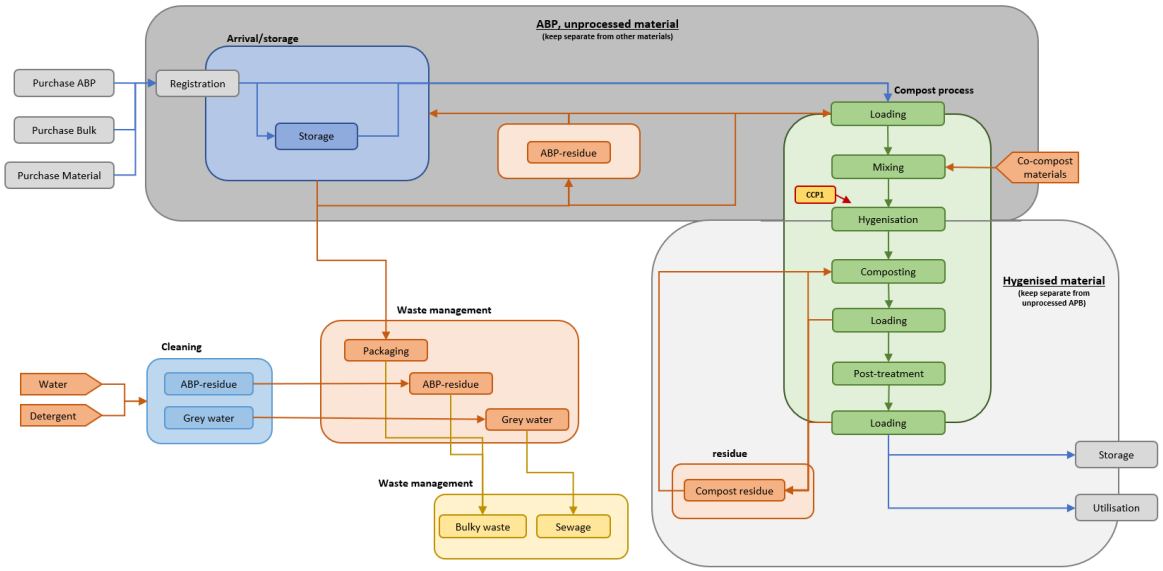


Fig. 5. Flow schedule from the permit application, showing our suggested plan for management of waste mussels.

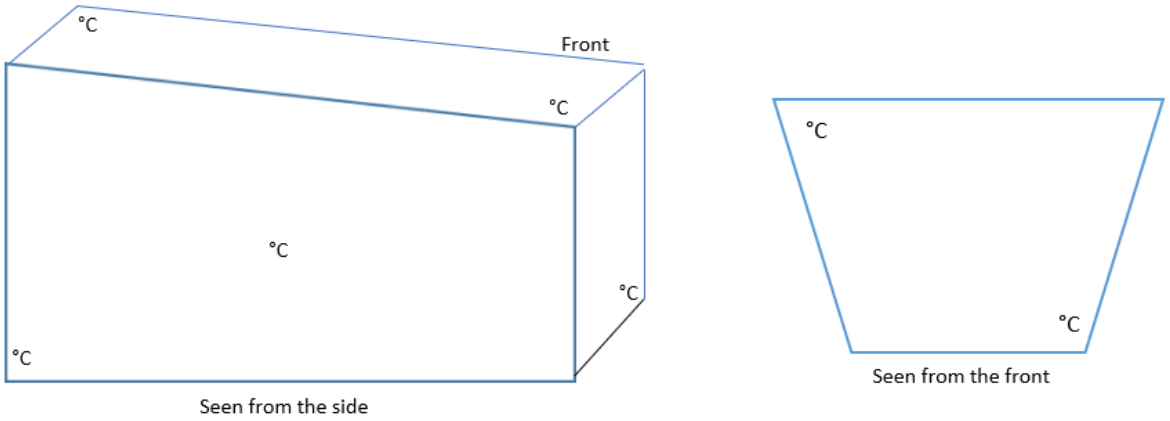


Fig. 6. Sketch of the critical control points for temperature measurements in the container.

3.2 Conditions for the temporary permit

The Swedish Agricultural agency granted a one-year permit for "Use of animal by-products in compost experiment". The main conditions were as follows:

- Only after the temperature treatment reached >52°C for 13 hours may the spill mussels be spread in the field.
- Particle size of the mussels cannot be >12 mm after mixing
- If treatment fails, the mussels must be re-treated or sent to some other plant for handling of animal by-products
- The compost must not be placed close to production animals
- Bacterial sampling shall take place at 4 times during or immediately past the treatment, to be analysed by an accredited laboratory and to show results below legal thresholds for the following species/genera: *Escherichia coli, Enterococcaceae, Salmonella*
- If salmonella is found, the compost must be handled or discarded according to instructions from the Agricultural agency.

4. THE COMPOST EXPERIMENT

4.1 Recipe and preparation of the mixture

The waste mussels were mixed with discarded silage and straw, materials that are commonly found in farms everywhere. The mixing was done in portions, while checking the weight and moisture content. The final mix consisted of:

- 1500 kg mussels
- 1950 kg wet silage (straw)
- 800 kg dry silage (straw)
- 350 kg straw

Total weight: 4600 kg

The mix was similar to the recommended recipe 1 (60% straw 40% mussels) from Biocompost AB, but due to high water content of the materials, additional straw was added to reach the recommended moisture content (Fig. 7). The proportion of mussels to straw in the final mixture was therefore 66% to 33%. During preparation, the mussels were grinded and blended for about an hour (Fig. 8). After the blending was finished, only small fragments of the shells could be seen.

Fig. 7. Discarded silage and straw were loaded into the container and mixed with the mussels.

Fig. 8. Picture taken in the beginning of the mixing process when whole mussels could still be seen. The materials emitted heat while mixing.

4.2 Equipment for temperature measurements

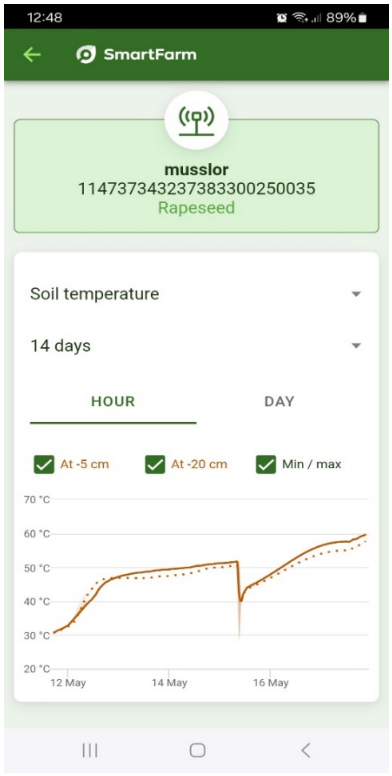
Temperature loggers and sensors were purchased from Pentronic AB. Both the sensors and the loggers were designed for tough environments and could be left inside the compost throughout the whole experiment. Two of the sensors were of stick-in (spear-like) model and

pushed through the material all way down to the bottom of the container. The other two sensors were wires and used to measure the surface temperature. In the middle of the mixture, a SmartFarm sensor was placed to enable remote monitoring of temperature in the compost (Fig. 9).

Fig. 9. Equipment for temperature measurements. Upper left: A thermocouple logger with 2 channels. Middle left: A stick-in sensor for measurement of temperature at the bottom of the container. Middle right: A waterproof wire-sensor for measurement of surface temperature. Lower left: The Smart Farm sensor. Inset picture: Close-up of a logger.

4.3 Treatment and monitoring of the compost

When the substrates were readily mixed, the temperature sensors were mounted at a respective control point and the container was covered with a tarp to protect it from insects, rain and drought. The mix was prepared on May 11th, and stayed in container for 10 days until May 21st, during which time the temperature development was followed remotely by the SmartFarm sensor.



On May 13-14th, the initial rise in temperature had stagnated. On May 15th, both the tarp and sensors were temporarily removed and the mixture was blended again for about 20 minutes. The data was downloaded from the loggers, and it was discovered that no data had been logged at CP ”Bottom front” due to loose connection. This was adjusted, and the temperatures started to rise again (Fig.10).

Fig. 10. Left: Screen dump from the SmartFarm app, showing how the temperature in center of the compost changed over time. Note the sudden dip on the 15th of May, when the sensor had been removed from the container during mixing. The re-mix was followed by a rapid temperature rise.

5. RESULTS AND PLAN FORWARD

5.1 Results

5.1.1 Temperature treatment

On May 20th, the target temperature of 52°C had reached at all control points (CPs), however not consistently, and the heat was unevenly spread through the biomass. A last mixing was tested at 10 am, and from 4pm the temperature had raised well above 52°C at all CPs and it stayed over 52° C for 14 hours, with a maximum temperature reaching over 60°C at all four points. The process was finally concluded on May 21st.

Some conclusions from the temperature measurements are:

1) The target temperatures were reached without external heating or insulation;

2) The discarded silage, most cheap and easy of the suggested co-compost materials, could be used for mixing;

3) Mixing was required (only) at three occasions.

With regular monitoring, the mixing could be kept to a minimum. However, it was important to mix the materials at some points in order to speed up the process, and also to get a more even distribution of heat in the container (Fig. 11).

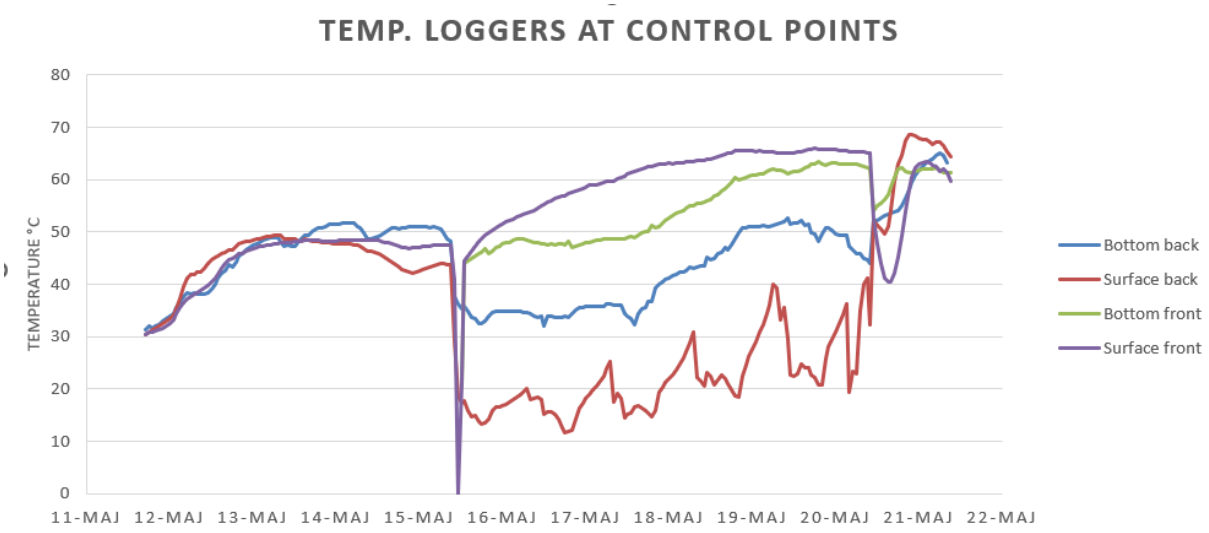


Fig. 11. Measurements on May 20th showcasing that the target temperature of 52°C had reached at all control points, however not consistent. A last mixing was performed at 10am, and from 4pm onwards the temperature stayed above 52°C for 13 hours in a row at all CPs.

5.1.2 Bacteria samples

After the last mixing on May 20th, and when terminating the process on May 21th, a total of 5 bacteria samples were taken for the analyses required in our permit. Samples were collected from the surface and bottom of the mixer (bottom samples were taken through the feed dispenser), as well as after mixing. The samples were sent fresh to Eurofins accredited laboratory. We are still awaiting the results.

5.2 Plan forward

This report will be sent to the Swedish agriculture agency for evaluation, together with our logged raw-data and results from bacterial analyses. Should this compost method be approved for the hygenisation of waste mussels, Ecopelag AB will seek to acquire a mixer/container that is similar to the one used for this experiment. Permits will be applied if possible, for treatment of waste and spill mussels close to the factory. Some improvements to be made would be to insulate the mixer, and possibly to add some heating coils in order to be better equipped for the cold season.