Fig 1: Bokashi bucket system for lactic acid fermentation of food waste.

NORTHERN RESEARCH INSTITUTE NARVIK
PO Box 250 • NO-8504 Narvik, Norway
Tel: +47 76 96 53 50
Contacts for more info:
Joseph Kufi Tambwe; (47) 90 51 77 52; joseph@tek.norut.no
Ross Wakelin; (47) 99 252 485; ross@tek.norut.no
Website: http://norut.no/en/sted/norut-narvik

INVESTIGATIONS OF ANAEROBIC FERMENTATION OF FOOD WASTE ('BOKASHI' METHOD)

Aim – *To study the application of lactic acid anaerobic fermentation of food waste with the 'Bokashi' system, and its potential application in Narvik.*

Handling of food waste in Narvik

Currently household food waste in Narvik is transported to Kiruna for incineration with heat recovery, an arrangement that will soon be discontinued when Kiruna closes the incineration plant. Earlier, food was sent to Bodø for composting for use as soil fertiliser, but cold climate conditions pose challenges for this process. The quantity of organic waste available in the Narvik region is not sufficient for production of biogas by the traditional wet fermentation process. Hence NORUT Narvik is investigating alternative processing options.

What is 'Bokashi'?

The Bokashi system of processing food waste was developed in Japan in 1982 by Prof Higa. It is claimed that the special combination of microorganisms can achieve a faster breakdown of the food waste into forms that plants can utilise as nutrient sources. While composting is an aerobic process, requiring access to oxygen, Bokashi is an anaerobic process, where air should be excluded. This helps eliminate problems with odour, as the process is performed in closed containers. While there are many different microorganisms the dominant species are of lactic acid-producing bacteria, as are used in other fermentation processes (such as pickling and yoghurt). The acidic conditions limit the growth of pathogenic microorganisms and the unpleasant odours.

Advantages and disadvantages of Bokashi

As an anaerobic process little heat is generated by the Bokashi process. Since the process is performed anaerobically in a closed container, this can be located indoors, in the kitchen. This avoids the challenge of avoiding freezing of the food waste. The process is a form of "solid state fermentation, with no additional water added, hence the processing is compact and takes little space. However, the Bokashi fermentation needs to be completed by mixing with soil to finish the degradation and mature the product. This likely needs to be done outdoors.
The products from Bokashi (both solid and liquid fertiliser) are acidic, which may not suit all applications.

How is the bokashi fermentation performed?

The food waste is placed in a plastic container that has a perforated plate allowing excess liquid to drain away. As the food waste is placed in the container it is added the starter microorganisms that are inoculated onto wheat bran. The container is then kept sealed to reduce the introduction of oxygen and kept at room temperature. As the fermentation proceeds some components are broken down and are leached out in a fluid. This has a high content of organic acids as well as nutrients.
After around 2 weeks the fermented food waste is mixed at about 50/50 into soil and the degradation then proceeds faster, yielding a garden soil product.

Topics for investigation

In this study NORUT Narvik wishes to investigate some practical details regarding the use and application of Bokashi. Some of the questions to be answered are described below:

What size of container is needed

Two sizes of container are available from the supplier of the Bokashi system: 25 and 100 litre. Which size (or how many) containers are needed depends on the rate at which organic waste is generated, how dense the waste is packed, and how long the waste should be treated for.

Fig 2: Containers with 25 litre capacity

Sourcing food waste

To start with, waste from the NORUT Narvik lunchroom was gathered, but this was found to generate too little waste (32 g/person/day), and was dominated by fruit peel. Subsequently, the collection was extended to include waste from a 4-person family, with two small children, generating a greater quantity of waste (550 g/person/day).

Characterisation of food waste

To be able to plan for the size of number of processing containers needed it is necessary to determine the rate at which the waste is generated and what volume it occupies. By weighing and measuring the volume the density of the food waste can determined, and compared with values from the literature.

The dry matter content is determined by drying in an oven at 105 °C, the volatile solids content determined by measuring the ash content after incinerating at 550 °C. The solid and liquid products can be analysed in terms of their acidity, nutrient content and effect on plant growth.

What can the leachate be used for?

The instructions suggest that the leachate should be diluted before using as a liquid fertiliser for plants. This is said to be due to the highly concentrated nutrients. It could also be necessary to dilute to reduce the effect of the acidity. Studies of the leachate offer different conclusions regarding the suitability of the leachate as a fertiliser. One report [2] recorded high levels of phosphor and potassium, but too low levels of nitrogen to allow its use as a full fertiliser.

What properties to the final soil product have?

The other main question is how quickly the fermented food waste breaks down into a garden soil product. This process will be studied in the summer when the soil was thawed. It is necessary to confirm that the soil product has achieved the stability and maturity needed for promoting plant growth. It is known from traditional composting that immature compost can restrict plant growth due to high organic acid contents.

Quality control of products

The maturity of the fermented waste product as well as the appropriate dilution level of the leachate for use as a fertiliser can be determined with a seed germination test. It is reported [3] that Pak Choy (Chinese cabbage) seeds (*Brassica rapa*), are the most sensitive to the maturity of compost.

Conclusions

Results from the study will be published through the NORUT webpage.

References

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Contact at NORUT Narvik

Joseph Kufi Tambwe; (47) 90 51 77 52; joseph@tek.norut.no