PROJECT SUMMARY

Pilot-scale production of enhanced-value anaerobic digestion waste (digestate) derived bioproducts on the Darling Downs

KEY POINTS

- Agricultural recycling of food waste digestate is a practicable environmentally beneficial option. Being rich in nutrients such products are highly valuable to farmers looking to eliminate the use of synthetic fertilisers.
- In this project a novel granulated organo-mineral fertiliser product was developed that meets quality criteria and requirements of current farming practices and spreading equipment.
- The results of research have demonstrated the fertilising potential of food waste digestate, food waste containing biosolids and derived granulated organo-mineral fertiliser.

THE CHALLENGE

Current rates of food waste (FW) digestate uptake by farmers is low due to the unbalanced nutrients composition and overall (poor) physico-chemical quality of the material which does not meet the requirements of modern farming practices and farm equipment.

THE OPPORTUNITY

Optimisation of the physico-chemical properties of FW digestate should ensure acceptability by farmers and secure the agricultural route for on-farm application. A fertilisation strategy that could be interesting as opposed to "monotype" fertilisation (organic only vs. mineral only) is the use of balanced combined organo-mineral fertiliser created by mixing an organic amendment (s) (such as FW digestate, biosolids and biochar) and mineral industrial fertiliser. There are significant differences in nutrient availability between digestate and mineral fertilisers. Nutrients in mineral fertilisers are generally in a soluble form, and when applied are immediately plant available. In contrast, a large proportion of nutrients in digestate are in organic forms which must first to be mineralised to be plant available. This presents both a challenge and an opportunity by blending or reacting mineral fertilisers with organic fertilisers to produce so-called organo-mineral fertilisers (OMF).

OUR RESEARCH

The aim of research is to develop a new commercial product(s) that maximise the nutrient recovery from FW digestate and food waste containing biosolids by improving the composition and physical characteristics of the final product.

This research utilises a purpose-built prototype equipment (laboratory scale granulator) whereby FW digestate blended with urea and clay will be turned into solid granular fertiliser. A multi-scale experimental work that included laboratory, glasshouse and field-based studies was conducted to:

- Develop the specifications for novel, enhanced-value FW digestate-derived products (OMF) that meet the requirements for field application using standard farm equipment (physical and mechanical properties) and nutritional needs of crops (chemical composition).
- Experimentally evaluate the proposed product formulation (s) and product format, determine the agronomic value of OMF.
- Such a development will enable improved resource use efficiency and will likely deliver tangible benefits both to growers (reduced reliance on mineral fertilisers) and wastewater industry and municipalities co-digesting food waste (reduced cost of disposal) and increase opportunities to meet long-term nutrient recycling targets.

METHODOLOGY

The project assesses the agronomic/nutrients value of biosolids contained food waste and food waste digestate based organo-mineral fertiliser: in laboratory, glasshouse and field conditions.

The project plan is summarised as followed:

- Laboratory testing and analysis of all materials used in experimental work.
- Design, formulation and production of organo-mineral fertiliser, based on food waste digestate.

The Fight Food Waste Cooperative Research Centre is funded through the Australian Government's CRC Program administered by the Department of Science, Industry and Resources.

- Glasshouse study: assessing agronomic/fertiliser potential of biosolids containing food waste.
- Inter-laboratory trial: incubation experiment using granulated organo-mineral fertiliser.
- Field testing of granulated organo-mineral fertiliser.
- Assessment of fertiliser replacement values of FW based OMF.

RESULTS

FW containing biosolids were sourced fresh from a Wastewater Treatment Plant. FW digestate was obtained from commercial anaerobic digestion facilities. Granulated OMF was made by combining commercially available urea fertiliser with biochar, FW digestate from commercial anaerobic digestion facilities and Ca bentonite. The granules were formulated based on the proportions of total nitrogen concentration provided from urea, biochar, and FW digestate. Bentonite was added as a binding agent. Granulated fertiliser was manufactured using laboratory scale EIRICH Intensive Mixer system (Figure 1) which allows the complete production of fertiliser granulates in one process step by means of agglomeration from dry powders and suitable for manufacturing organic based fertiliser.

A multi-scale experimental work included: a) laboratory study – incubation and leaching experiments; b) glasshouse study – pot trial; c) field-based study – testing OMF application using standard spreading equipment.

Figure 1. EIRICH granulator and granulated OMF.

The results of research have demonstrated the fertilising potential of FW digestate and OMF for use in agriculture. The product specifications for novel fertiliser materials have been established and acceptability by farmers should not be a barrier to increasing the amount of biosolids and FW digestate (and derived fertiliser materials) currently being recycled to agriculture. Produced granulated product meets quality criteria and the requirements of current farming practices and farming spreading equipment. The field trial demonstrates the successful distribution of the granulated material in field condition.

In the glasshouse experiment, all fertilised pots exhibited significantly higher yield than the unfertilised controls. Biosolids containing food waste, OMF and urea treatments increased dry matter yield comparing to control pots by 63% for biosolids and OMF and 41% for urea treated ryegrass. The application of biosolids containing food waste increased heavy metals availability comparing to control and OMF amended soil, but the concentration of heavy metals in all amendments were under the maximum levels accepted by the current Queensland legislation and both OMF and biosolids used in this study are suitable for land application.

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OUTCOMES

The results of research have demonstrated the fertilising potential of FW digestate and OMF. Based on current results, it is concluded that biosolids containing food waste and OMF are more efficient than mineral fertiliser for all rates applied in terms of producing higher yield. The product specifications for novel fertiliser materials have been established, produced granulated product meets quality criteria and the requirements of current farming practices and farming spreading equipment. The field trial demonstrates the successful distribution of the granulated material in field condition.

IMPACT

Use of biosolids and other organic waste as a fertiliser contributes to the global circular economy, benefits society through reducing greenhouse gas emissions by displacing fossil-fuel derived fertilisers, reduces food waste and generates profit for industry.

It is anticipated that this project will:

1. Create new circular economy jobs through increased adoption of anaerobic digestion and newfound production of granulated OMF.
2. Reduce greenhouse gas emissions through reducing the use of synthetic chemical fertiliser, increase food waste to anaerobic digestion to create biogas which can be used to displace fossil-fuel derived fuels,
3. Increase industry profitability through reducing disposal costs and increasing market potential by simultaneously drying and formulating a granulated product for transport to major grain growing regions.

NEXT STEPS

Future agronomic studies should consider investigating options for improving nutrient use efficiency through adjustments to the timing of fertiliser application and fertiliser placement and the longer-term effects of routine fertiliser applications on potentially toxic elements (both heavy metals and organic contaminants).

There is also a need to perform further and more detailed economic analyses when the actual cost of production of FW digestate based OMF to the required quality are known.

PROJECT TEAM

- Dr Serhiy Marchuk (Fight Food Waste Cooperative Research Centre, University of Southern Queensland)
- Professor Bernadette McCabe (Fight Food Waste Cooperative Research Centre, University of Southern Queensland)

PROJECT REPORTS/PUBLICATIONS

Marchuk, S., McCabe, B., (2023). Pilot-scale production of enhanced-value anaerobic digestion waste (digestate) derived bioproducts on the Darling Downs, Final Project Report. Fight Food Waste Cooperative Research Centre.

PARTICIPANTS

University of Southern Queensland

PROJECT WEBPAGE

PILOT-SCALE PRODUCTION OF ENHANCED-VALUE ANAEROBIC DIGESTION WASTE-DERIVED BIOPRODUCTS ON THE DARLING DOWNS - End Food Waste Australia » End Food Waste Australia

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