Investigation of the Physical, Chemical and Microbiological Parameters Influencing the Small-scale In-vessel Composting of Food Waste

D. Orthodoxou, T.R. Pettitt, M. Fuller, M. Newton, N. Knight, S.R. Smith

CYPRUS 2016

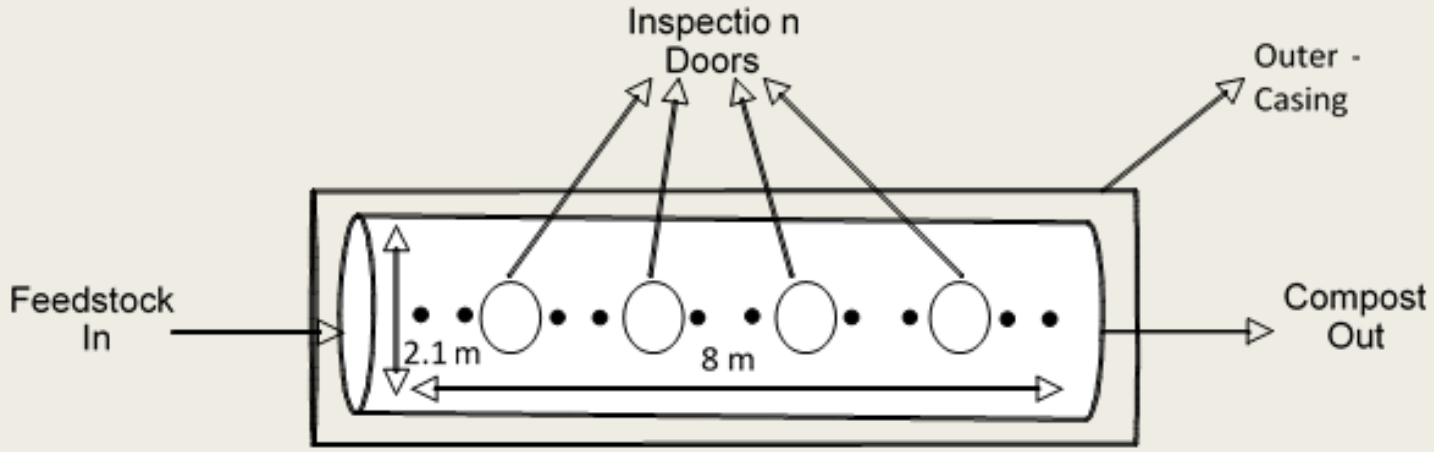
Food Waste (FW): a challenging feedstock

- Needs bulking agents, otherwise it becomes highly homogeneous
- High moisture content
- Often very acidic
- Collection in closed containers can lead to anaerobic conditions, further lowering pH
- Must be treated in an enclosed environment, specified time-temperature conditions

The role of VFAs in FW composting

- Initial decrease in pH is often observed after FW addition to IVC. In severe cases this can lead to significant decline in temperature and malodours
- VFAs in compost mixture play key role in regulating pH during mesophilic phase
- Acidic compost mix (pH<6) → undissociated VFAs → inactivation of aerobic microorganisms → accumulation of VFAs → further acidification
- Mesophilic aerobes are more acid tolerant than thermophilic organisms
- Maintaining the compost temperature below 46°C until the pH value increases above pH 6.5, allows aerobic organisms to degrade VFAs, thus shortening the mesophilic phase and increasing the composting temperature in a shorter period of time

In-vessel FW composting at the Eden Project



- FW shredded to 20mm particle size
- Retention time between 60 and 110 days (depending on feeding rate)

Feedstock

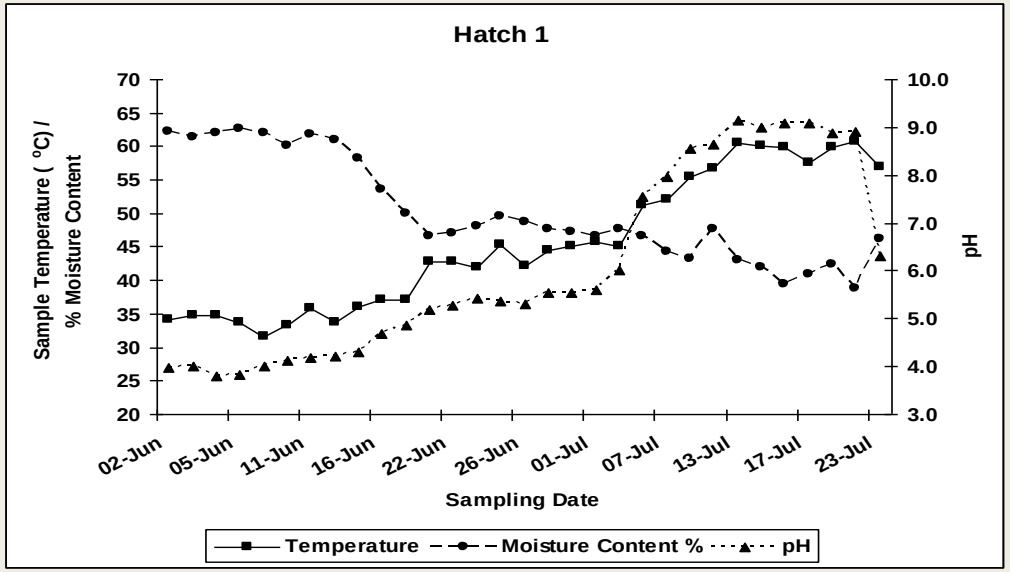
Feedstock	pH	Characteristics
Food Waste (FW)	4.0-4.4 after shredding	High MC, little porosity
Green Waste (GW)	6.0-8.0	Increases C/N ratio. Adds microbial population
Corrugated Board Dust (CBD)	8.0	Low MC (~11%). Drying agent
Sawdust (SD)	5.6-5.8	Drying agent
Sawdust Pellets (PEL)	4.7	Low MC (~15%). Expands on rehydration, increases free air space
Finished Compost (FC)	7.5-8.5	Drying agent. Adds thermophilic organisms

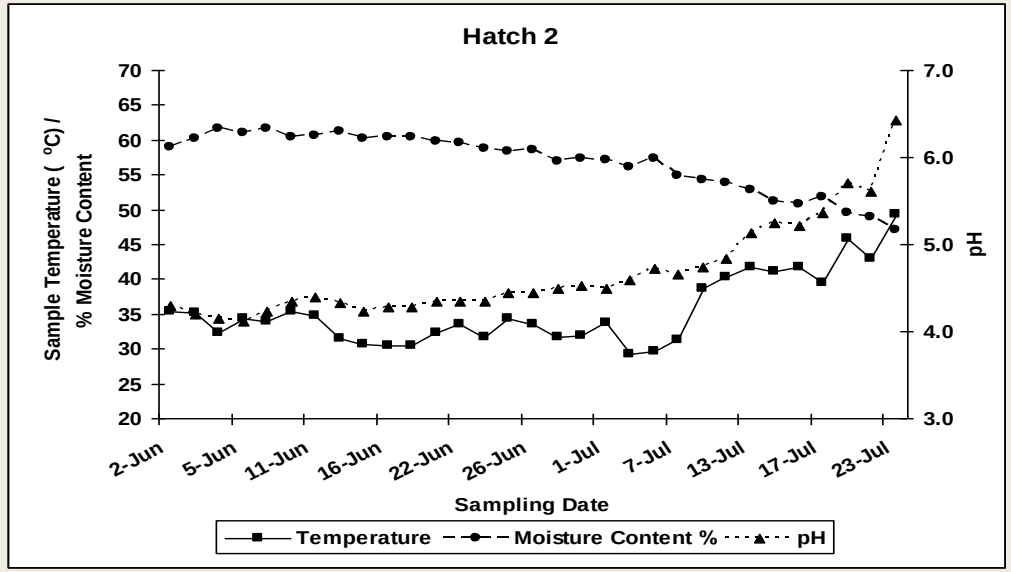
Eight week feedstock management strategy

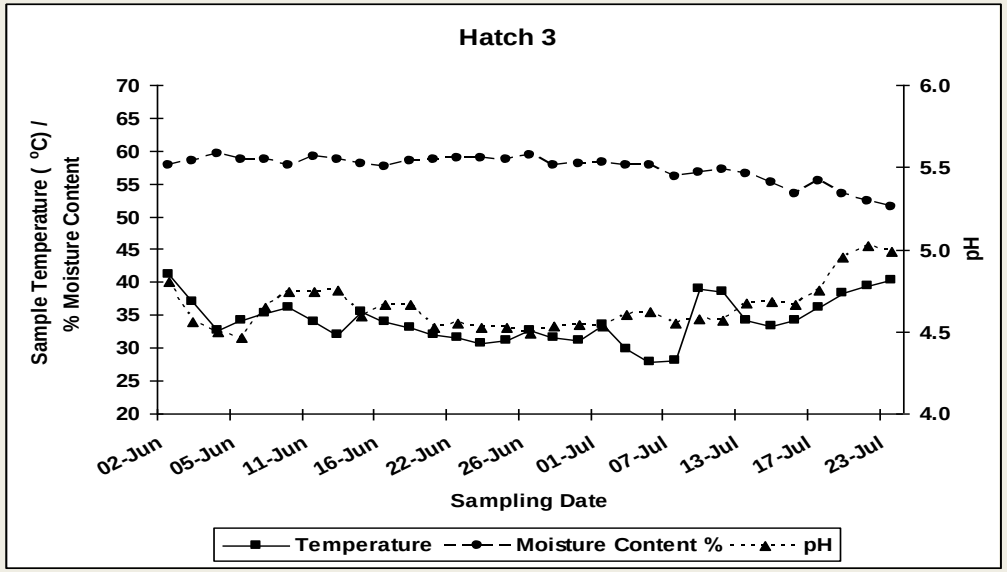
Input (kg):	Week							
	1	2	3	4	5	6	7	8
FW	572	-	-	-	-	14	224	279
GW	208	300	101	197	84	350	205	84
FC	80	172	681(565)	-	-	-	115	47
CBD	99	125	34	132	119	-	-	-
SD	-	5	22	-	-	-	-	-
PEL	-	-	-	16	-	242	30	30
Total Input:	959	602	838	345	203	606	574	440
Total Output (kg):	194	-	(55)*	388	179	579	189	-

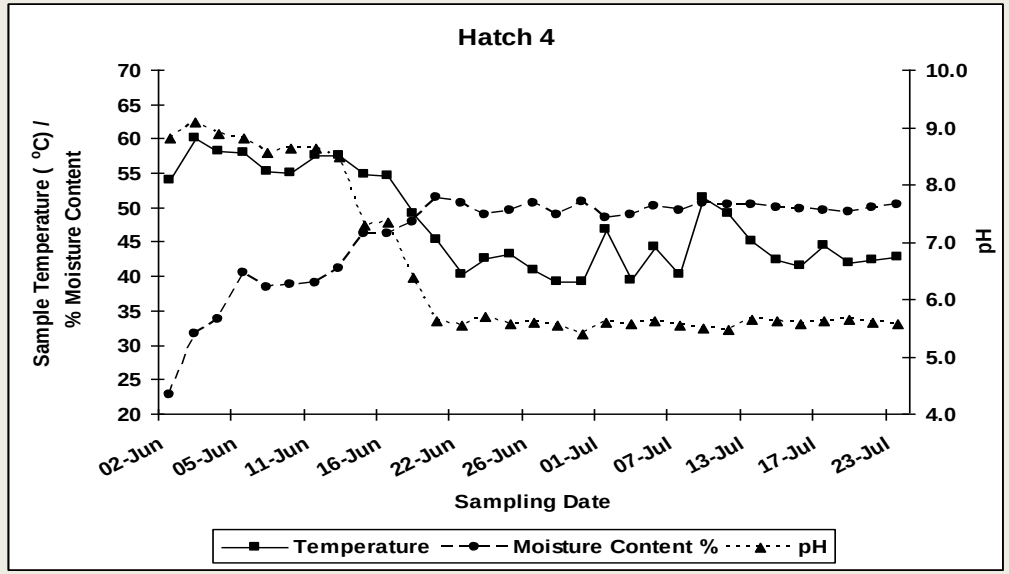
* Value in brackets represents the material removed from the discharge end of the vessel and recycled to the feed end.

Changes in temp., moisture content and pH

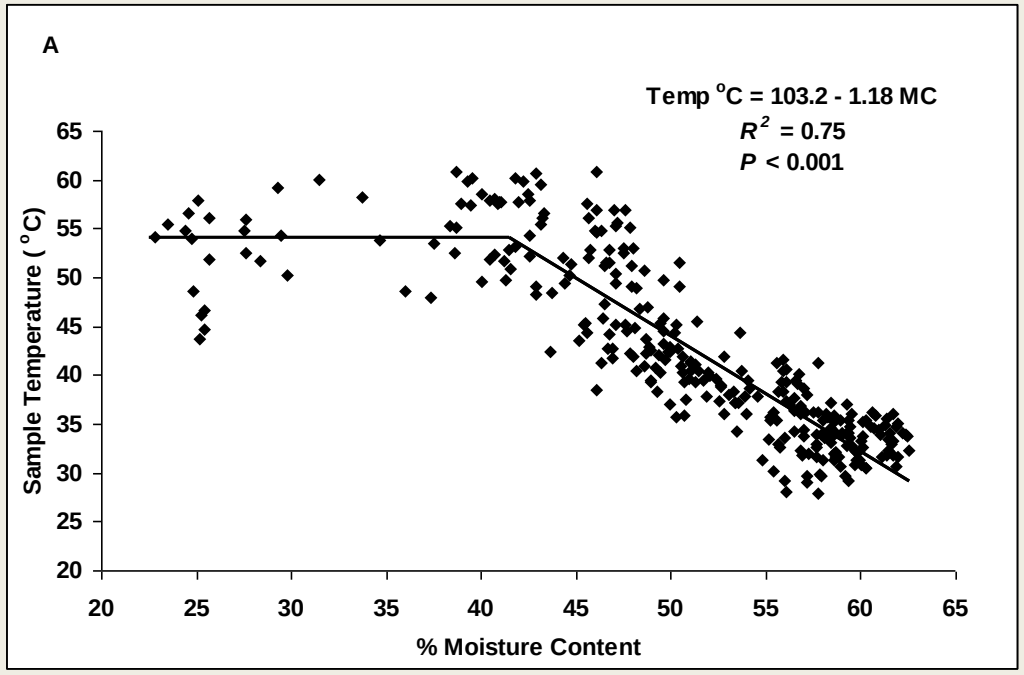


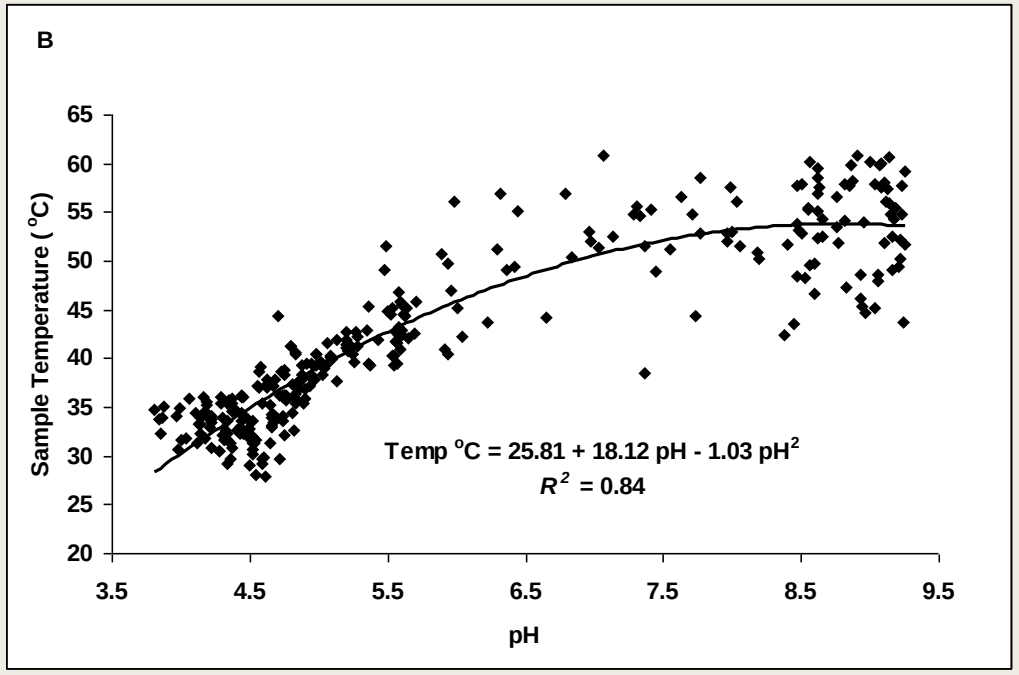




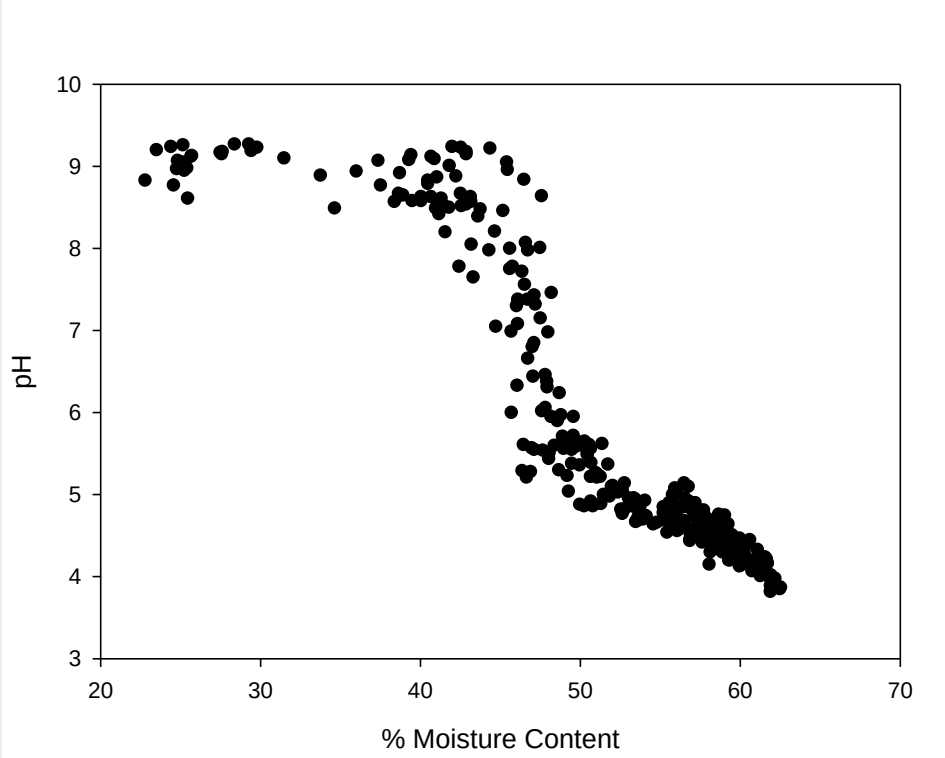


The effect of MC and pH on the temperature of the compost mixture

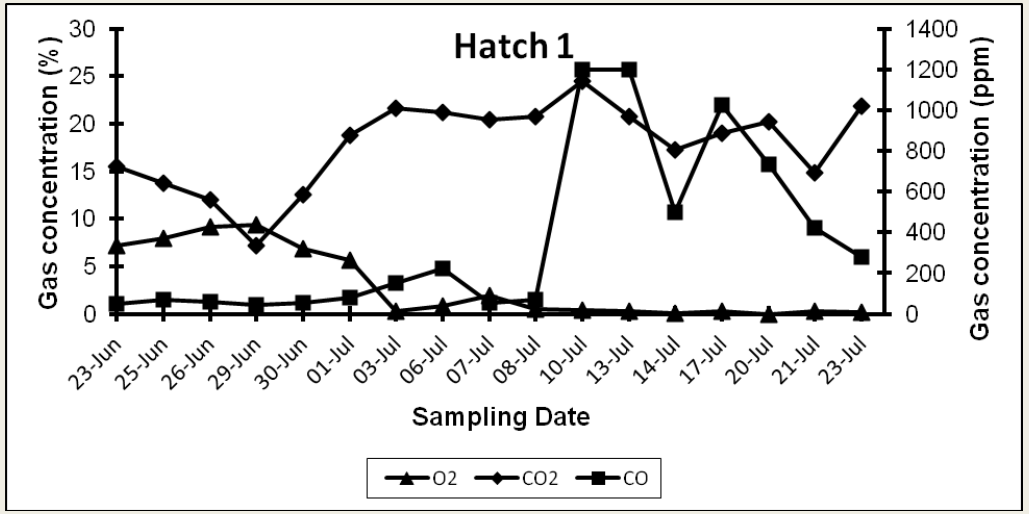


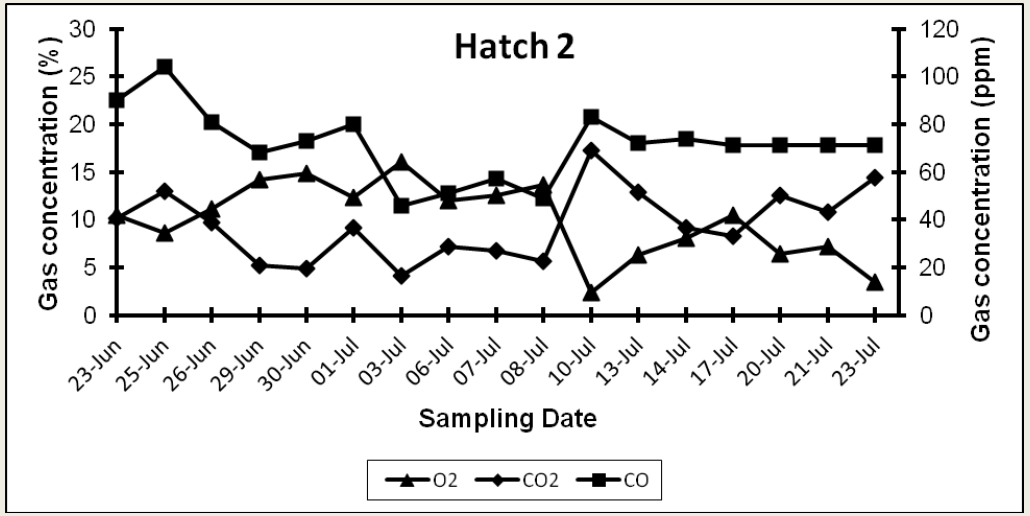


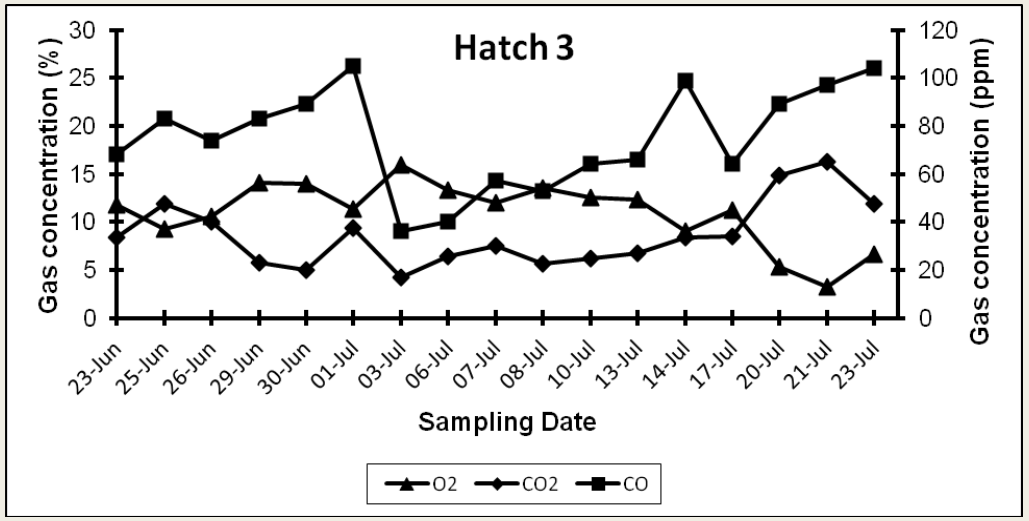
The effect of % moisture content on pH

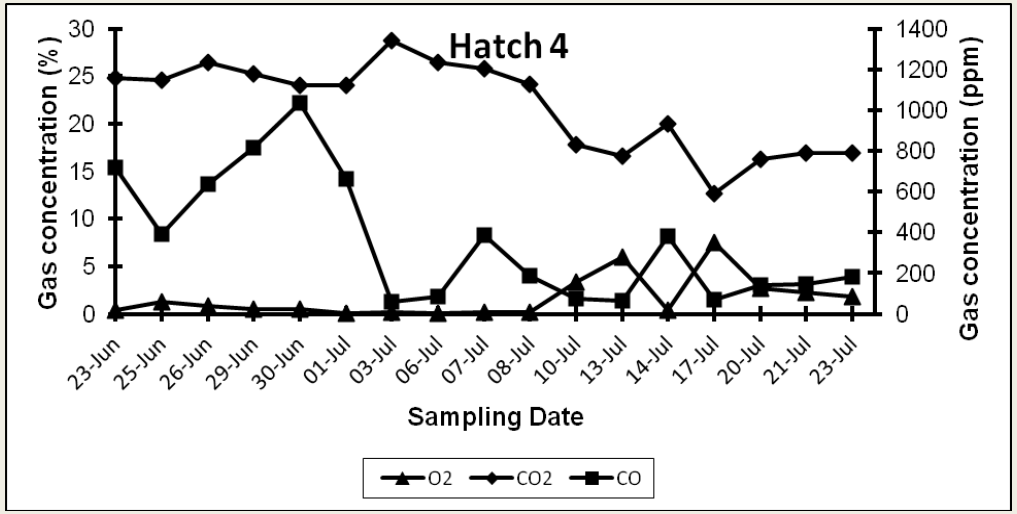


Interstitial gas concentrations

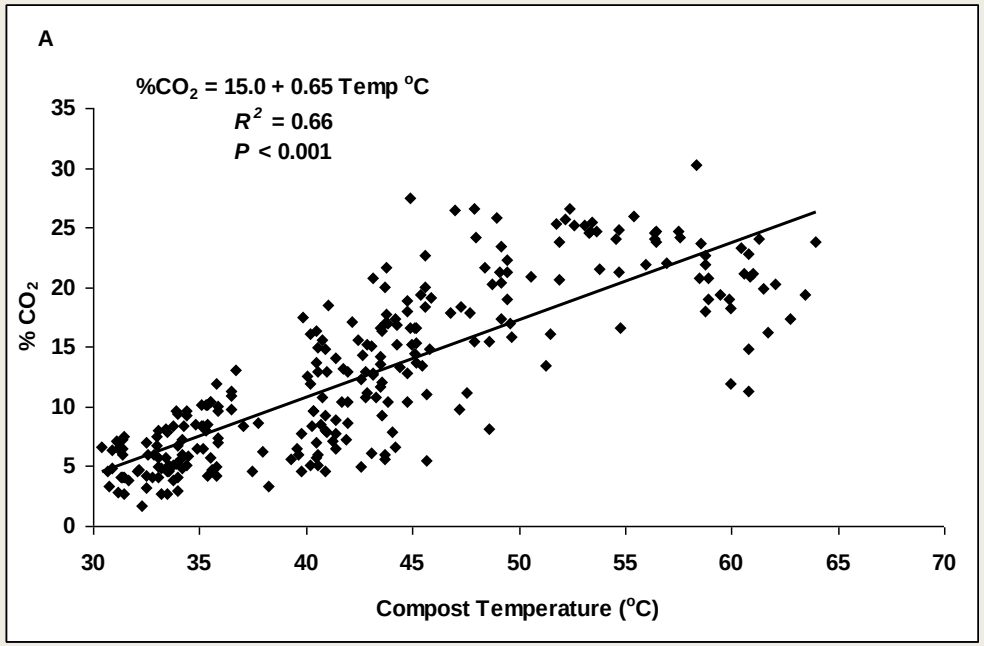


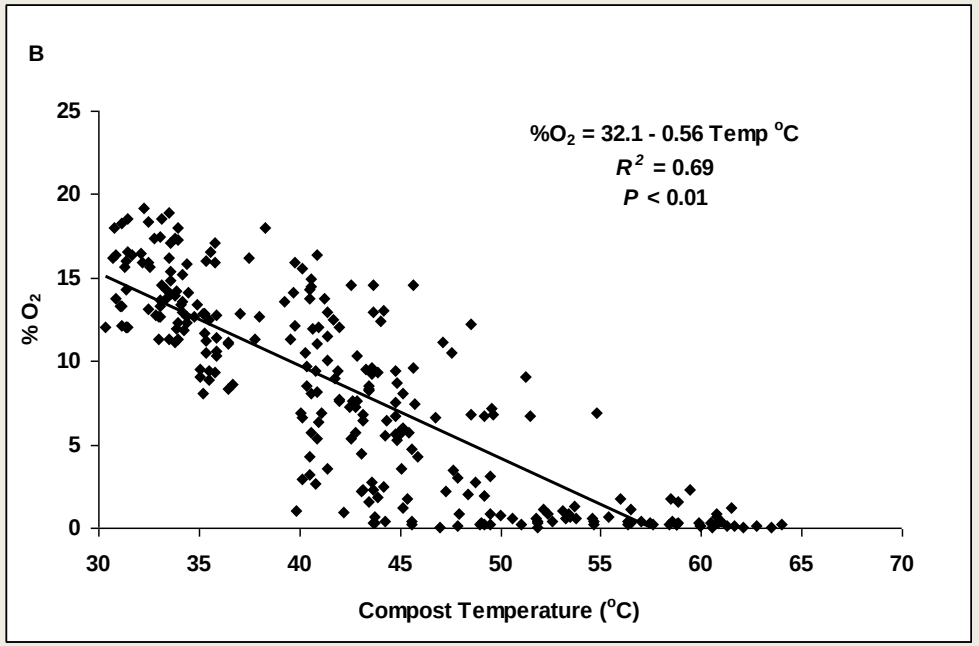






Relationship between temperature and C02 and temperature and 02





Conclusions

- The rapid biodegradation of FW makes its composing susceptible to acid accumulation and pH decline.
- The results show that process acidification is highly sensitive to increasing MC.
- Possible reason: MC influences the thermodynamic balance of the process. A wet mixture leads to greater heat losses, causing a decline in temperature and a decline in VFA metabolism. Feedback mechanism leading to more VFA accumulation and pH reduction → microbial toxicity → process inhibition.
- MC between 41-48% were associated with a marked transitional increase in compost pH above 6.0 and a concomitant rise in temperature to thermophilic values
- Moisture contents over 48% caused severe acidogenesis and mesophilic temperatures
- Under the conditions of this investigation the upper critical MC for in-vessel composting of food waste was 40% (whereas the recommended MC for composting is in the range of 40-60%).

Orthodoxou, D., Pettitt, T.R., Fuller, M., Newton, M., Knight, N., Smith, S.R. (2015). An Investigation of Some Critical Physico-chemical Parameters Influencing the Operational Rotary In-vessel Composting of Food Waste by a Small-to-Medium Sized Enterprise. *Waste and Biomass Valorization,* 6 (3)

Thank you!