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Valorization of food waste leachates through anaerobic digestion.

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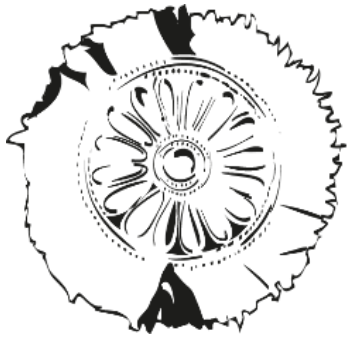

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✓ Anaerobic digestion:

- is an environmentally favourable technology and the most widespread good practice for the biodegradation of household waste.
- is a complex biochemical process in which organic material is decomposed by several groups of microorganisms in the absence of oxygen while renewable energy such as biogas is generated.
- combines waste treatment and renewable energy recovery.
- reduces the odor of waste material
- digestate is rich in nutrients that can be used as fertilizer after the process of fermentation

✓ Important to monitoring factors such as: pH, Total Solids, Volatile Solids, Ammonium, Chemical Oxygen Demand, Total Phosphorus, Alkalinity, Volatile Fatty Acids, Total Organic Carbon and Total Nitrogen.

✓ Sampling

- Compost leachates were collected during the period May 2020 to May 2021. Mainly consisting of fruits and vegetables, and their sampling procedure were from different stages of the composting process.

❑ Description of the Samples

Date of Sampling	Sample Name	Description of Sample
1/6/2020	S1	Raw material from bucket of public market
12/6/2020	S2	Raw material from bucket of public market
22/6/2020	S3	Raw material from bucket of public market
22/6/2020	S4	Raw material from bucket of public market
3/11/2020	S5	Leachate from mechanical composting plants
22/12/2020	S6	Leachate from mechanical composting plants
17/3/2021	S7	Leachate from waste transfer station
17/3/2021	S8	Leachate from waste transfer station
28/4/2021	S9	Leachate from waste transfer station
28/5/2021	S10	Leachate from waste transfer station

➢ Analytical methods

Parameter	Standard Method
pH	4500 H^+,APHA 23th Ed
Alkalinity	2320 B, APHA 23th Ed
NH_4^+	EPA 350.1
COD	EPA 410.1
TP	EPA 365.2+3
TS	2540 B, APHA 23th Ed
VS	2540 F, APHA 23th Ed
VFAs	Kapp (Titration)
TC,TOC,IC	5310 B, APHA 23th Ed
TN	2720 C, APHA 23th Ed

➢ HPLC VFAs Analysis

- Isocratic elution
- Mobile phase (0,02mol/l KH2PO4/methanol) 98:2
- Acidified with H3PO4 to pH 2,88
- 50 min
- Flow rate was 0,6 ml/min at 35 °C
- 20μl injection volume

❖Standard stock solution containing 100mg/l :

- Acetic Acid
- Propionic Acid
- Butyric Acid

✓ Results of complete characterization of Food Waste Compost Leachates

❑ Complete characterization of compost leachate. VFAs represent the cumulated concentration of acetate, propionic and butyric acid.

Parameter	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
pH	4,29	4,65	4,52	3,84	4,02	4,82	4,35	4,91	4,48	4,05
TS (g/l)	118	24	69	114	36	18	33	26	41	60
VS (g/l)	98	14	45	100	28	14	25	17	31	48
COD (mg/l)	47202	49500	51800	38850	53924	16620	40154	25102	25601	31794
NH_4^+ (mg/l)	470	956	985	212	134	138	104	303	484	117
TOC (mg/l)	15580	14150	14140	34430	13930	7368	9990	19885	16660	3692
TN (mg/l)	2558	3435	3588	3973	579	267	314	511	771	273
VFAs (g/l)	30508	18349	16041	37046	41780	8847	12768	14874	21613	24946
C/N ratio	6,1	4,1	3,9	8,7	24,1	27,6	31,8	38,9	21,6	13,5

✓ Results of complete characterization of Food Waste Compost Leachates

❑Major and minor trace elements of compost leachate

Parameter (mg/l)	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Na	6208	7210	7506	7005	3980	2075	233	577	552	1251
K	874	869	891	1329	145	280	1011	1320	1905	2779
Mg	337	227	226	532	370	166	90	316	168	895
Zn	1,4	2,1	2,1	4,3	4,0	1,4	12	27	18	16
Fe	203	335	340	164	281	357	1,4	0,5	31	32
Cu	0,3	0,3	0,5	0,6	0,6	0,2	0,6	0,3	1,1	1,6
Pb	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Ni	nd	nd	nd	nd	nd	nd	1,5	1,0	1,2	2,5
Cr	nd	nd	nd	nd	nd	nd	1,2	3,4	3,3	2,6
Cd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Mn	nd	nd	nd	nd	nd	nd	1,2	1,2	3,8	3,4

✓ Results of complete characterization of Food Waste Compost Leachates

Samples from brown bin (S1-S4):

- Rich in nutrients
- C/N ratio not acceptable for composting (too low)
- No presence of toxic metals

Samples Leachate (S5-S10):

- Rich in nutrients
- C/N ratio acceptable for composting
- No presence of toxic metals

VFAs :

- High Concentrations
- Low pH values of the samples due to the high concentrations of VFAs
- Contributor to odour nuisance
- Precursor Compounds for methane production in anaerobic digestion process
- Composting process is initial stages/raw compost material
- Compost immature

✓ BioMethane Potential Test

✓ 3 Different SIR

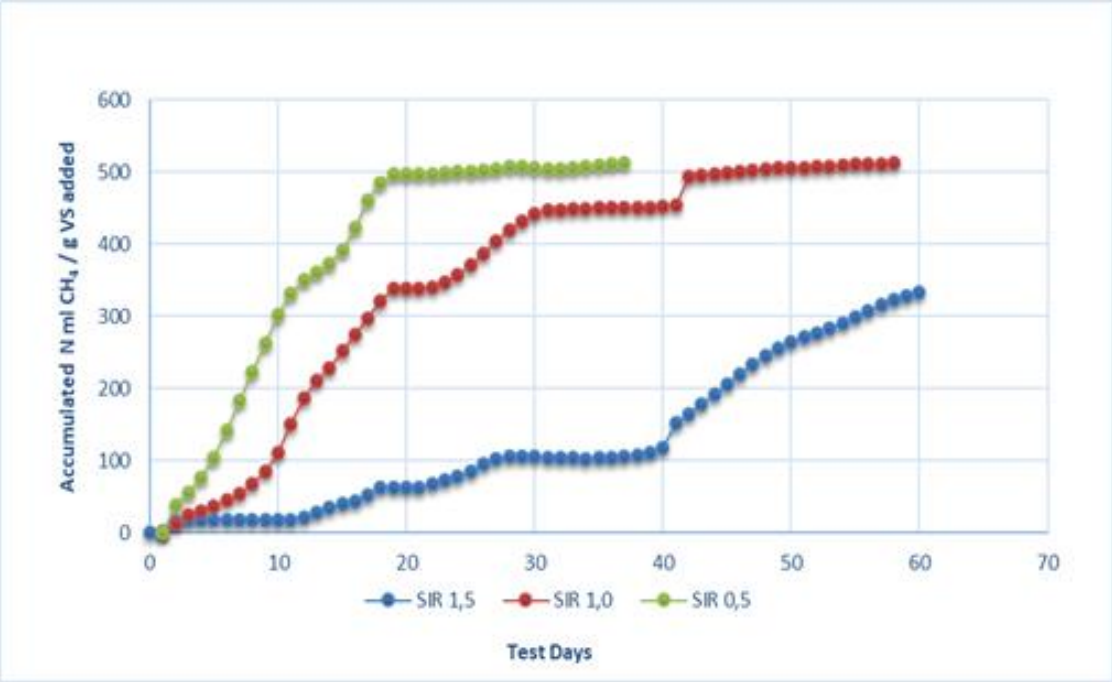
❑ Composition of the SIR feedstocks and inoculum.

Parameter	Inoculum	FW (0,5)	FW (1,0)	FW (1,5)
Alkalinity (mg/l CaCO3)	15000	3225	4150	5075
VS (mg/l)	24000	2400	4800	7200
COD (mg/l)	22820	8173	16047	23921
NH_4^+ (mg/l)	972	67	83	103
TOC (mg/l)	6623	952	1940	2930

❑ Main characteristics of each bench scale bioreactor during the start-up and after the end of the batch experiment. VFAs represent the cumulated concentration of acetate, propionic and butyric acid.

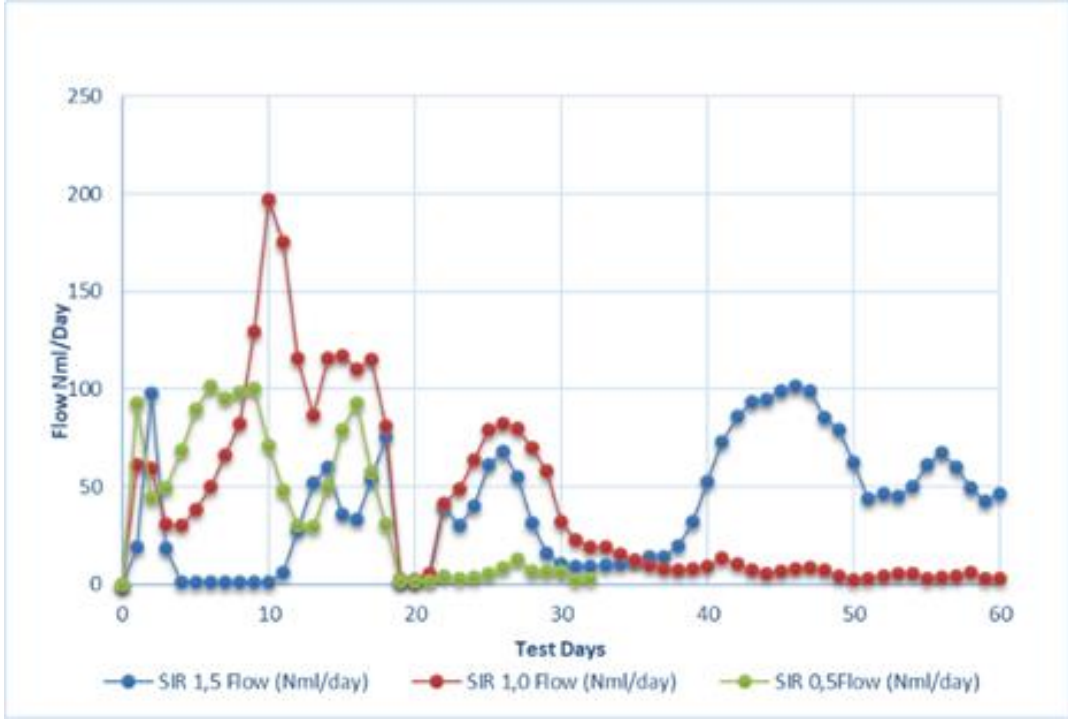
Parameter	FW (0,5)		FW (1,0)		FW (1,5)	
	Initial Concentration	Final Concentration	Initial Concentration	Final Concentration	Initial Concentration	Final Concentration
pH	6,41	7,95	6,03	7,79	5,80	7,88
VS (g/L)	19,54	2,65	31,6	4,24	47,38	4,71
VFAs (mg/L HACeq)	4371	1678	5175	1076	9366	948
NmL CH_4/g VS	512,00		511,76		333,02	
COD (mg/L)	7138	1204	12451	3349	26880	3983
NH_4^+(mg/L)	552	1053	818	1553	669	1355
Test Days	32		60		60	

✓ BioMethane Yield



❑ Accumulated Nml CH4/g VS added of SIR 0,5, 1,0 and 1,5

❑ Flow (Nml/day) of SIR 0,5, 1,0 and 1,5



- SIR 1,5 : 330 Nml/g VS added in 60 days (Substrate:150mL)
- SIR 1,0 : 512 Nml/g VS added in 60 days (Substrate:100mL)
- SIR 0,5 : 512 Nml/g VS added in 32 days (Substrate:50mL)

Monitored the changes of Food Waste Compost Leachate (Seasonality, Composting process time):

- High Organic Load
- Rich in nutrients
- High Volatile Fatty Acids
- No presence of toxic metals
- Compost characterized as immature(in this stage of process)
- The usage of Leachate recommended in low application rates or after dillution

BioMethane Potential Test of Food Waste Compost Leachate:

- Ideal Substrate for Anaerobic digestion
- The degradation of COD of the SIR 0,5, 1,0 and 1,5 were 83,13%, 73,11% and 85,18% respectively
- SIR 0,5 produced higher biomethane yield (512 Nml CH_4/g VS) at the half days (32) of the procedure

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