BIOCHEMICAL METHANE POTENTIAL OF VARIOUS PROMISING AGRICULTURAL RESIDUES IN SOUTHERN AND NORTHERN GREECE

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LBEET
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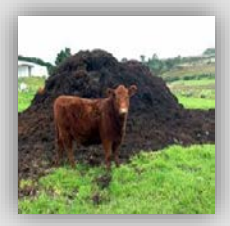
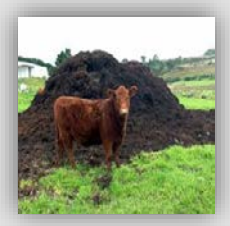
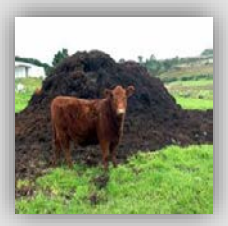
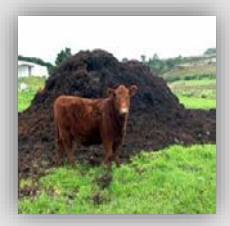
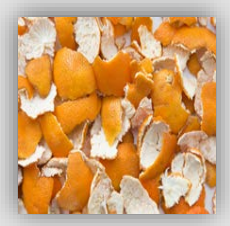
INTRODUCTION

- Greece: strong agro-industrial sector
- *Almost 70%* of its total area is used for agricultural activities
- Main categories of generated residues

PROPOSED SUBSTRATES FOR ANAEROBIC DIGESTION

- Humidity> 50-55%
- 15<C:N<30

- Abundancy
- Ease of collection

Northern Greece	Southern Greece
Summer   	Summer    
Winter   	Winter    

MATERIALS AND METHODS

- Collection of samples from the region of Western Greece ⟹ storage in the freezer at -18 ° C
- Protocol for BMP measurement: *"Defining the biomethane potential (BMP) of solid organic wastes and energy crops"*
- BMP assays for Northern & Southern Greece (Summer and/or Winter)
- Tested Substrates:



Northern Greece: summer & winter



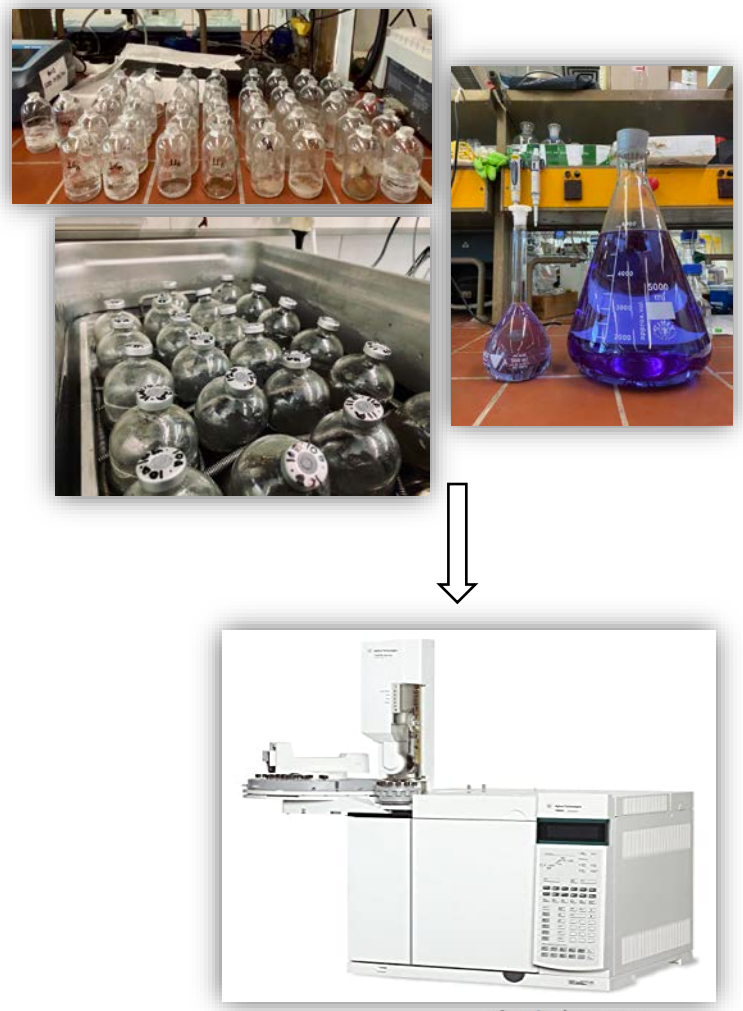

Southern Greece: summer

BIOCHEMICAL METHANE POTENTIAL ASSAYS

- BMP: experimental procedure developed to determine the maximum methane potential of a given organic substrate during its anaerobic decomposition

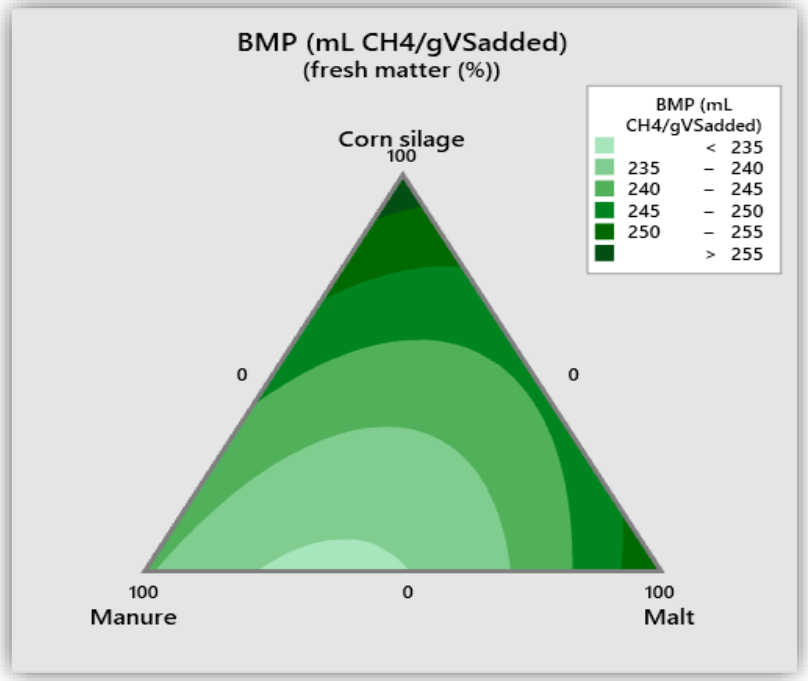
- Experimental BMP design: use of DOE mixture (Design of Experiments), Minitab 19

- For mixtures, the proportions of the ingredients are variable (0-100% v/v), while their total quantity remains unchanged (2 g VS L^{-1})



BMP RESULTS
NORTHERN GREECE (SUMMER AND WINTER)

Corn silage (%w/w fresh matter)	Cattle manure (%w/w fresh matter)	Malt (%w/w fresh matter)	Corn silage (%VS)	Cattle manure (%VS)	Malt (%VS)	Measured BMP (ml CH_4 g VS_{added}^{-1} ± SD)	Expected BMP (ml CH_4 g VS_{added}^{-1})
0	0	100	0	0	100	255.23 ± 16.40	-
100	0	0	100	0	0	262.40 ± 34.37	-
0	100	0	0	100	0	236.08 ± 3.36	-
0	50	50	0	12.14	87.86	239.35 ± 11.17	252.90
50	0	50	62.14	0	37.86	259.25 ± 10.04	259.68
50	50	0	92.23	7.77	0	254.60 ± 7.28	260.36
33.33	33.33	33.33	59.05	4.97	35.98	238.60 ± 5.87	258.51
16.67	16.67	66.67	28.40	2.39	69.21	232.65 ± 10.96	256.81
66.67	16.67	16.67	85.22	1.79	12.98	226.70 ± 32.53	260.99
16.67	66.67	16.67	51.39	17.31	31.31	243.03 ± 8.94	255.60

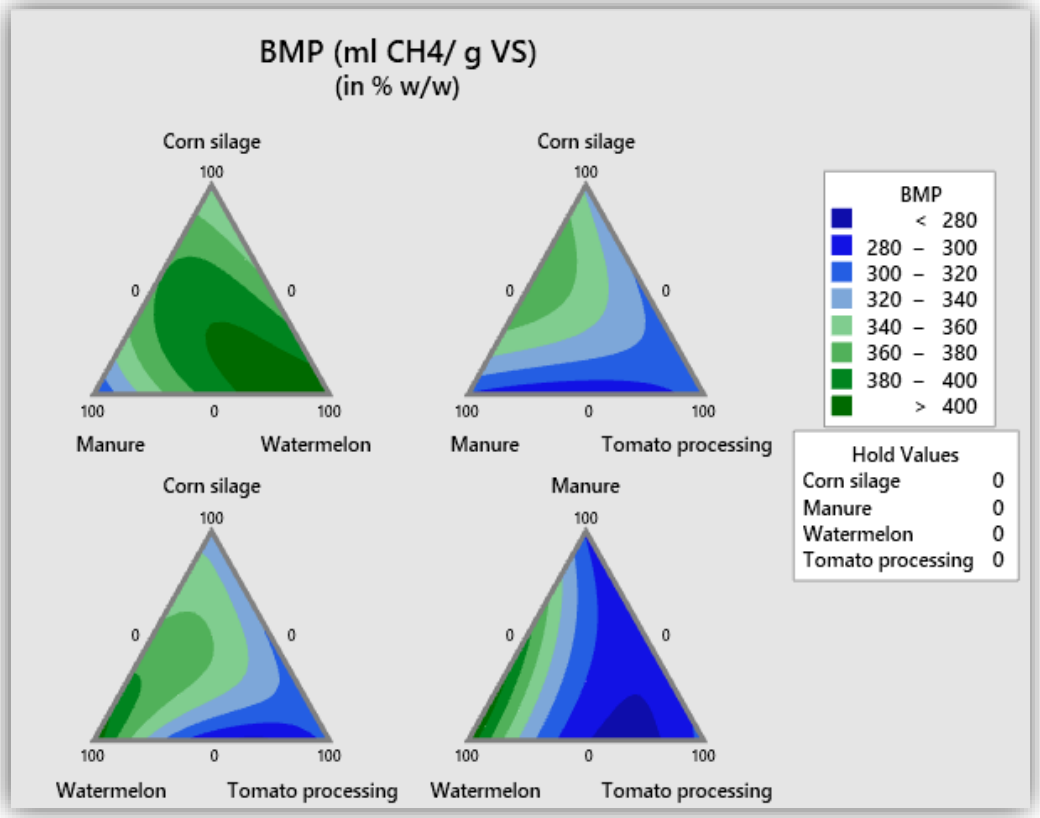


$$Expected\ BMP\ \left(ml\ CH_4\ \text{g}\ \text{VS}_{\text{added}}^{-1}\right) = \frac{(V_{S1} * VS_{S1} * BMP_{S1}) + (V_{S2} * VS_{S2} * BMP_{S2}) + (V_{S3} * VS_{S3} * BMP_{S3})}{V_{S1} * VS_{S1} + V_{S2} * VS_{S2} + V_{S3} * VS_{S3}}$$

$$Y\ (ml\ CH_4/g\ VS_{added}) = 2.58 Corn\ silage + 2.41 Manure + 2.55 Malt - 0.001 Corn\ silage * Manure - 0.004 Corn\ silage * Malt - 0.005 Manure * Malt$$

BMP RESULTS
SOUTHERN GREECE (SUMMER)

Corn silage	Cattle manure	Watermelon	Tomato processing residues	BMP (mL CH_4/g VS ± SD)	Expected BMP (mL CH_4/g VS)
(%w/w fresh matter)					
0	0	0	100	305.53 ± 27.82	-
100	0	0	0	329.20 ± 27.65	-
0	100	0	0	294.10 ± 49.14	-
0	0	100	0	420.98 ± 3.43	-
0	0	50	50	284.18 ± 41.40	319.94
0	50	0	50	281.05 ± 11.60	304.42
0	50	50	0	390.58 ± 8.38	366.53
50	0	0	50	311.55 ± 8.91	318.79
50	0	50	0	365.85 ± 3.96	338.45
50	50	0	0	374.50 ± 12.94	326.47
0	33.33	33.33	33.33	294.40 ± 13.36	317.72
33.33	0	33.33	33.33	346.53 ± 44.58	324.82
33.33	33.33	0	33.33	326.60 ± 33.94	317.67
33.33	33.33	33.33	0	389.83 ± 24.57	335.32
25	25	25	25	360.13 ± 2.86	323.51
12.5	12.5	12.5	62.5	328.88 ± 7.67	312.48
62.5	12.5	12.5	12.5	397.53 ± 31.29	327.32
12.5	62.5	12.5	12.5	358.15 ± 2.69	319.24
12.5	12.5	62.5	12.5	367.45 ± 13.36	341.49



$$Y(ml\ CH_4/\mathrm{g\ VS_{added}}) = 3.36016 * Corn\ silage + 2.96731 * Manure + 4.1688 * Watermelon + 3.08904 * Tomato\ Processing + 0.02449 * Corn\ silage * Manure - 0.00454 * Corn\ silage * Watermelon - 0.00295 * Corn\ silage * Tomato\ processing + 0.01226 * Manure * Watermelon - 0.00825 * Manure * Tomato\ processing - 0.03257 * Watermelon * Tomato\ processing + 0.00039 * Corn\ silage * Manure * Watermelon + 0.00038 * Corn\ silage * Manure * Tomato\ processing + 0.0013 * Corn\ silage * Watermelon * Tomato\ processing - 0.00019 * Manure * Watermelon * Tomato\ processing$$

CONCLUSIONS OF BMP ASSAYS
NORTHERN GREECE (SUMMER AND WINTER)

- The BMP results of the mono-substrates are in agreement with the existing literature
- There were no statistically significant differences or synergies between the substrates
- Higher BMP values: close to 100% malt or corn silage
- Parameters such as availability, reactor's characteristics and type of anaerobic digestion could determine the proportion of substrates

CONCLUSIONS OF BMP ASSAYS
SOUTHERN GREECE (SUMMER)

- The values of the mono-substrates are in agreement with the existing literature
- Most promising mixture: 12.5% corn silage-12.5% cattle manure-62.5% watermelon-12.5% tomato processing residues
- Higher BMP values: close to 100% watermelon
- Synergistic and antagonistic phenomena were also exhibited, depending on the mixture composition and the physicochemical characteristics of the substrates

FUTURE WORK

- BMP assays completion for the determination of the optimum substrates' ratios for maximum methane production (scenarios of Summer and Winter, Southern Greece)

- Continuous stirred tank reactors operation - Organic loading rate tests

THANK YOU FOR YOUR ATTENTION

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