C.R.E.A.R. CENTRO RICERCA ENERGIE ALTERNATIVE E RINNOVABILI

DISPAA DIPARTIMENTO DI SCIENZE DELLE PRODUZIONI AGROALIMENTARI E DELL'AMBIENTE

PHYSIC-CHEMICAL CHARACTERIZATION AND BIOGAS PRODUCTION POTENTIAL EVALUATION OF ALTERNATIVE AGRICULTURAL SUBSTRATES

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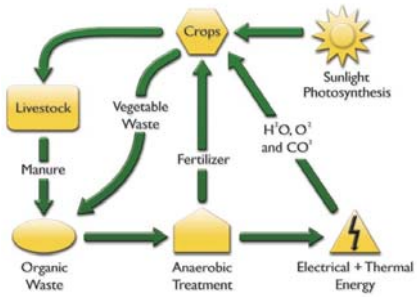
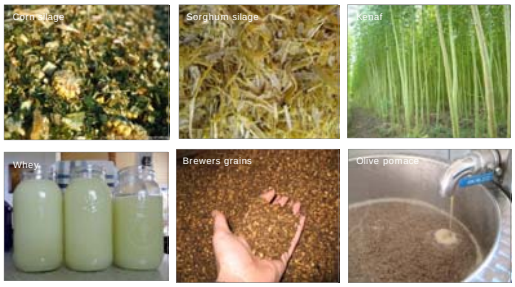
Biogas is a biogenous and renewable source of energy that contributes to a sustainable material and energy use. The growing interest in the use of alternative substrates, compared to specialized energy crops, has led to considering and testing different agricultural and agro-industrial substrates as alternate feeds for biogas production.





Several substrates were selected in this study and their biogas production potential was assessed by analyzing their physic-chemical characteristics with CHN and TGA. Substrates characterization were used to estimate the theoretical production of biogas, estimated with Buswell formula (*Buswell and Symons*, 1933)

$$C_nH_aO_bN_cS_d + (n - a/4 - b/2 + 7/4\,c + d/2)\,H_2O = (n/2 - a/8 + b/4 - 5/8\,c + d/4)\,CO_2 + (n/2 + a/8 - b/4 - 3/8\,c - d/4)\,CH_4 + c\,NH_4HCO_3 + d\,H_2S$$

Where n, a,b,c,d are the number of moles

TGA

CHNS

	Moisture (wb) %	Ash (db) %	C (db) %	H (db) %	N (db) %	S (db) %	O (db) %	VS %	TS %	Ash %
Corn	81,00	0,50	50,67	6,20	0,83	0,20	36,98	14,00	71,41	28,59
Sorghum	80,00	7,65	46,46	5,51	0,96	0,17	39,24	22,00	84,63	15,37
Pelargonioum	19,00	10,67	46,46	5,19	1,04	0,20	36,53	77,22	94,01	5,99
Kenaf	76,01	7,93	57,40	4,06	1,10	0,13	29,30	24,00	97,73	2,27
Sunflower	78,70	24,84	62,95	3,14	1,10	0,11	7,87	21,33	90,00	10,00
Amaranth	74,00	26,40	41,40	4,66	1,70	0,20	25,67	25,41	77,84	22,16
Olive pomace	64,60	4,40	63,90	6,88	0,80	0,20	23,80	35,44	95,61	4,39
Jatropha cake	52,40	1,96	58,55	6,08	3,40	0,20	29,82	47,62	98,00	2,00
Vinasse	69,02	1,14	32,05	8,13	2,20	0,20	56,29	31,00	96,54	3,46
Cpw'S whey	99,10	0,06	1,13	11,00	0,30	0,00	87,51	0,91	100,0	0,00
Sheep's whey	92,50	0,79	3,41	10,70	0,48	0,00	84,62	7,56	93,33	6,67
Brewes grains	72,30	0,91	44,00	6,43	1,80	0,05	46,82	27,74	95,62	4,38

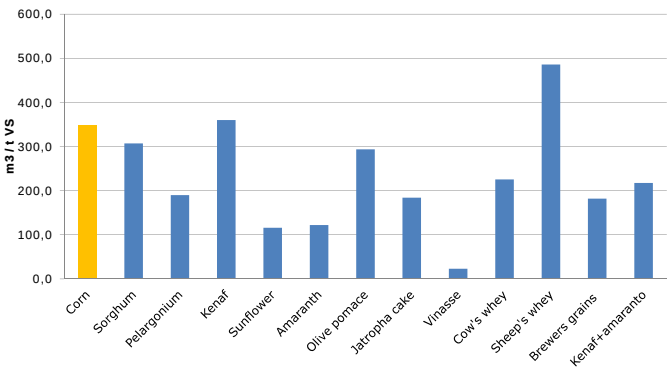
Wb=wet basis; db=dry basis; VS=volatile solid; TS=total solid

Results

Evaluation of BMP tests

- Kenaf silage produced a biogas amount (370,5 m^3/t SV) larger than corn (347,94 m^3/t SV)
- Wheys have high yields (483,9 m^3/t SV) of biogas and can be used as a booster for initiating or improving the process of anaerobic digestion)
- Olive cake produced an amount of biogas (310,7m^3/t SV) fairly comparable with that of corn (347,94 m^3/t SV).

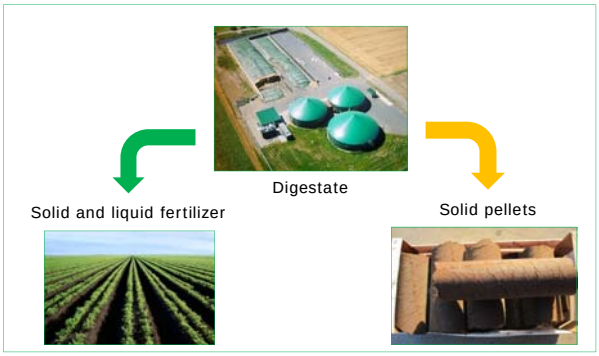
Angelidaki I., et al. (2009) – Defining the biomethane potential (BMP) of solid organic wastes and energy crops: a proposed protocol for batch assays. Water Science & Technology



	calculated		measured	
	CH_4 in biogas (%)	Biogas yield (m^3/t)	CH_4 in biogas (%)	Biogas yield (m^3/t)
Corn	53,1	498,0	52,76	347,9
Sorghum	52,2	481,3	55,00	307,1
Pelargonium	52,3	497,9	88,89	189,9
Kenaf	51,2	586,2	84,25	360,2
Sunflower	55,4	853,0	59,39	115,9
Amaranth	55,9	566,0	63,97	122,0
Olive pomace	59,4	732,8	54,71	293,7
Jatropha cake	57,0	603,4	71,70	184,1
Vinasse	56,2	319,8	65,53	22,8
Cow's whey	64,2	10,5	54,66	225,4
Sheep's whey	57,8	32,6	61,10	486,1
Brewers grains	52,5	419,7	55,00	181,8
Kenaf+Amaranth	53,2	577,5	74,11	194,4

Analysis of digestate

Use of digestate fertilizers or soil amendment or like solid pellets



	Moisture wb (%)	Ash db (%)	C db (%)	H db (%)	N db (%)	S db (%)	C.V. (MJ/Kg)	C/N
Corn	95,55	0,89	39,23	5,48	3,11	0,33	16,45	12.61
Sorghum	95,40	0,92	39,25	5,54	2,85	0,31	16,57	13.77
Pelargonium	95,00	1,00	38,67	5,39	2,73	0,36	16,08	14.16
Kenaf	95,26	6,40	40,00	5,13	2,72	0,40	16,65	14.71
Sunflower	94,24	24,00	39,00	5,01	2,61	0,32	16,51	14.94
Amaranth	94,40	2,00	37,75	5,28	2,15	0,34	15,18	17.56
Olive pomace	94,50	1,80	39,40	5,34	2,87	0,34	16,45	13.73
Jatropha cake	94,60	4,05	39,60	5,36	2,07	0,31	15,99	19.13
Vinasse	93,20	4,00	42,97	5,75	2,73	0,32	17,37	15.74
Cow's whey	97,30	3,70	34,35	4,75	2,40	0,38	15,10	14.31
Sheep's whey	96,90	3,75	36,07	5,03	2,73	0,38	14,87	13.21
Kenaf + Amaranth	95,51	0,90	38,17	5,44	2,87	0,38	15,94	13.30