

Biochar acts as an emerging soil amendment and its potential ecological risks: A review

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Table S1. Differences in physical and chemical properties of different types of biochar.

Feedstock	Pyrolysis temperature (°C)	pH	Ash (%)	Elements (%)							H/C	O/C	Surface Area (m ² g ⁻¹)	EC (ds m ⁻¹)	CEC (cmol kg ⁻¹)	Reference
				C	H	O	N	P	S	K						
Granular sludge	300	7.8 ± 0.1	-	53.5 ± 0.2	5.8 ± 0.1	-	9.0	0.2	-	0.06	0.11	-	-	-	-	[1]
		9.5 ± 0.1	-	48.0 ± 0.2	1.8 ± 0.1	-	6.9	0.3	-	0.09	0.04	-	-	-	-	
		9.7 ± 0.1	-	50.5 ± 0.2	1.0 ± 0.1	-	6.5	0.6	-	0.08	0.02	-	-	-	-	
	550	6.55 ± 0.05	-	11.19 ± 0.07	1.83 ± 0.01	-	1.72 ± 0.05	-	0.92 ± 0.05	-	0.16	-	36.8 ± 0.97	-	-	
		6.96 ± 0.05	-	8.61 ± 0.05	1.22 ± 0.05	-	1.31 ± 0.05	-	0.95 ± 0.05	-	0.14	-	51.5 ± 0.0	-	-	
		6.96 ± 0.05	-	8.61 ± 0.05	1.22 ± 0.05	-	1.31 ± 0.05	-	0.95 ± 0.05	-	0.14	-	51.5 ± 0.0	-	-	
Sewage sludge	300	6.55 ± 0.05	-	11.19 ± 0.07	1.83 ± 0.01	-	1.72 ± 0.05	-	0.92 ± 0.05	-	0.16	-	36.8 ± 0.97	-	-	[2]
		6.96 ± 0.05	-	8.61 ± 0.05	1.22 ± 0.05	-	1.31 ± 0.05	-	0.95 ± 0.05	-	0.14	-	51.5 ± 0.0	-	-	
		6.96 ± 0.05	-	8.61 ± 0.05	1.22 ± 0.05	-	1.31 ± 0.05	-	0.95 ± 0.05	-	0.14	-	51.5 ± 0.0	-	-	

		0.04			0.07		0.02		0.09				1.06			
	500	7.57	-	8.35 ±	0.85	-	1.18	-	0.98	-	0.10	-	57.5	-	-	
		±		0.06	±		±		±				6 ±			
		0.10			0.04		0.02		0.09				0.81			
	600	7.96	-	8.15 ±	0.59	-	0.94	-	0.95	-	0.07	-	54.5	-	-	
		±		0.06	±		±		±				2 ±			
		0.07			0.04		0.02		0.06				0.61			
	700	8.51	-	7.68 ±	0.41	-	0.66	-	0.94	-	0.05	-	50.2	-	-	
		±		0.12	±		±		±				7 ±			
		0.12			0.04		0.33		0.08				0.58			
Sewage	450	6.5 ±	62.	21.2 ±	-	-	1.8 ±	4.2 ±	1.0 ±	0.31	-	-	-	3.4 ±	18.9	[3]
sludge		0.3	2 ±	0.10			0.2	0.3	0.1	± 0.1				0.3	± 2.5	
			0.7													
			5													
Sewage	300	5.8 ±	-	23.4 ±	3.6 ±	-	3.3 ±	4.1	1.5	0.1	1.8 ±	-	20.2	-	-	[4]
sludge		0.2		0.4	0.1		0.1				0.1		± 1.8			
	500	6.5 ±	-	19.0 ±	1.7 ±	-	2.3 ±	6.1	0.7	0.1	1.1 ±	-	52.5	-	-	

		0.3		0.2	0.1		0.1				0.1		± 4.3			
Brewery	500	9.18	79.	14.76	0.61	82.2	2.14	0.85	0.28	0.59	0.49	5.57	-	0.60	46.62	[5]
wastewat			89			1										
er sludge																
Sewage	500	7.28	34.	43.0 ±	3.20	-	6.80	1.06	-	-	0.07	-	77.2	10.4	22.2	[6]
sludge		±	1 ±	0.05	±		±	±					±	±	±	
		0.05	0.0		0.02		0.01	0.05					0.75	0.05	0.11	
			5													
Sewage	200	6.54	68.	17.09	2.09	10.0	2.19	0.04	-	0.76	0.12	0.59	-	0.35	-	[7]
sludge			62			1										
	300	7.20	70.	19.72	1.79	5.76	2.59	0.02	-	1.0	0.09	0.29	-	0.11	-	
			14													
	500	8.70	79.	15.26	0.73	3.28	1.73	0.02	-	1.3	0.05	0.21	-	0.07	-	
			00													
	700	11.1	85.	11.33	0.31	1.90	0.71	0.01	-	1.3	0.03	0.17	-	0.10	-	
		5	75													
Sewage	550	8.2	-	-	-	-	0.23	0.01	-	-	-	-	-	1.9	-	[8]

sludge

Rice	400	7.87	2.3	51.41	2.75	20.4	1.45	-	-	-	0.64	0.30	1.35	-	11.09	[9]
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straw			89			9										
	700	10.7	3.2	55.85	2.08	9.47	1.30	-	-	-	0.45	0.13	9.72	-	9.70	
		3	69													

Rice	400	7.72	2.8	47.45	0.68	21.4	0.80	-	-	-	0.17	0.34	1.39	-	9.58	
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husk			23			3										
	700	10.3	4.0	50.22	1.14	7.35	1.07	-	-	-	0.27	0.11	10.0	-	6.40	
		9	22										2			

Rice	250	7.64	-	45.07	4.62	19.2	0.86	1.16	0.28	1.88	1.23	0.32	1.13	-	-	[10]
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straw						3							5			
	350	9.94	-	48.71	3.55	18.8	0.91	1.62	0.26	3.61	0.87	0.29	2.90	-	-	
						3							0			
	450	10.6	-	50.44	2.75	18.8	0.83	2.01	0.27	3.88	0.65	0.28	7.65	-	-	
		3				3							8			
	550	11.1	-	48.53	2.08	18.7	0.77	2.57	0.24	4.06	0.51	0.29	13.2	-	-	
		1				6							73			

	650	11.1	-	39.75	1.73	19.6	0.71	3.94	0.36	5.42	0.52	0.37	14.3	-	-	
		5			3	1							26			
Canola	250	7.19	-	46.19	4.98	45.5	1.07	1.90	0.68	1.40	1.29	0.74	0.66	-	-	
stalk						7							4			
	350	10.5	-	56.21	3.42	47.2	1.01	2.60	0.93	25.35	0.73	0.63	1.15	-	-	
		8				2							1			
	450	10.6	-	61.87	3.02	47.8	1.01	2.95	1.06	25.74	0.59	0.58	2.50	-	-	
		3				5							2			
	550	10.7	-	60.26	2.23	49.8	0.89	3.11	1.20	25.68	0.44	0.62	4.37	-	-	
		6				1							5			
	650	10.9	-	41.66	1.86	49.4	1.02	5.06	1.96	42.47	0.54	0.89	7.93	-	-	
		6				4							7			
Wheat	-	10.0	-	66.15	2.72	-	0.88	0.14	0.04	3.02	0.04	-	64.1	1.68	-	[11]
straw		2 ±		±	±		±	±	±	±			5	±		
		0.01		0.80	0.05		0.02	0.01	0.01	0.07				0.10		
Maize	-	9.99	-	53.50	2.66	-	2.17	0.72	0.08	2.29	0.05	-	76.3	1.66	-	
straw		±		± 0.11	±		±	±	±	±			3	±		

		0.01			0.02		0.00	0.06	0.04	0.18				0.01		
Orange	500	10.0	16.	72.3 ±	1.83	-	2.55	0.52	-	-	0.03	-	99.2	3.75	63.5	[6]
bagasse		±	1 ±	0.28	±		±	±					±	±	±	
		0.05	0.0		0.01		0.02	0.01					0.45	0.02	0.17	
			5													
Coconut	500	10.5	10.	79.5 ±	2.21	-	0.42	0.02	-	-	0.03	-	122	4.20	69.7	
shell		±	8 ±	0.06	±		±	±					±	±	±	
		0.06	0.0		0.01		0.01	0.05					0.05	0.05	0.17	
			5													
Oilseed	550	9.78	19.	68.85	1.82	8.91	1.29	0.29	-	2.86	0.32	0.10	7.30	2.27	-	[12]
rape		±	50	± 2.26	±	±	±	±		±	±	±		±		
straw		0.47	±		0.22	1.30	0.22	0.08		0.26	0.03	0.02		0.38		
			2.1													
			6													
	700	10.4	21.	67.74	1.09	7.84	1.26	0.26	-	2.98	0.19	0.09	25.2	3.11	-	
		1 ±	92	± 0.86	±	±	±	±		±	±	±	0	±		
		0.49	±		0.14	1.23	0.18	0.08		0.40	0.02	0.02		0.37		

		0.5															
		2															
Softwood pellets	550	7.91	1.2	85.52	2.77	10.3	<	0.06	-	0.25	0.39	0.09	26.4	0.09	-		
		±	5 ±	± 1.22	±	6 ±	0.10	±		±	±	±	0	±			
		0.30	0.4		0.09	1.19		0.04		0.07	0.01	0.01		0.03			
		2															
	700	8.44	1.8	90.21	1.83	6.02	<	0.07	-	0.28	0.24	0.05	162.	0.16	-		
		±	9 ±	± 0.39	±	±	0.10	±		±	±	±	30	±			
		0.69	0.4		0.15	0.74		0.04		0.09	0.02	0.01		0.06			
		3															
Wheat straw	300	6.6	22.	47.73	2.21	-	0.68	0.11	-	4.06	0.56	-	18.7	-	128.7	[13]	
		6															
		2															
Cow manure	300	8.48	42.	34.29	3.31	-	2.55	-	0.17	-	1.16	-	3.52	-	-	[14]	
		±	71	± 0.89	±		±		6 ±								
		0.02	±		0.16		0.07		0.01								
		0.3															
		6															
		2															

400	9.18 ± 0.01	45. 03 ± 0.2 1	36.90 ± 0.34	2.67 ± 0.04	-	2.62 ± 0.06	-	0.15 9 ± 0.00	-	0.87 6	-	5.01 -	-
500	9.36 ± 0.01	47. 99 ± 0.1 9	37.51 ± 0.21	1.99 ± 0.04	-	2.53 ± 0.08	-	0.15 9 ± 0.00	-	0.64 6	-	7.04 -	-
600	9.60 ± 0.01	51. 73 ± 0.0 1	38.47 ± 0.40	1.49 ± 0.02	-	2.15 ± 0.01	-	0.23 5 ± 0.00	-	0.46 3	-	13.9 -	-

	700	10.3 6 ± 0.02 0.4 3	54. 49 ± 0.01 0.42 3	36.97 ± 0.42 0.01	1.09 ± 0.01	- 0.04	1.45 ± 0.04	- 0.01	0.28 0.01	- 3	0.35 	- 	121. 10	- 	- 	
Swine manure	300	9.01 ± 0.04 0.5 6	50. 56 ± 0.5 6	32.58 ± 0.51 0.6	3.60 ± 0.08	11.5 1 ± 0.35	2.80 ± 0.06	- 	- 	- 	1.33 ± 0.01	0.26 ± 0.01	2.33 	1.12 ± 0.03	- 	[15]
	400	9.30 ± 0.07 0.7 2	58. 49 ± 0.7 2	30.15 ± 0.38 2	2.38 ± 0.09	6.21 ± 0.08	2.61 ± 0.05	- 	- 	- 	0.95 ± 0.01	0.16 ± 0.00	3.84 	1.24 ± 0.01	- 	

	500	9.88 ± 0.08 0.3 4	66. 88 ± 0.30	28.23 ± 0.05	1.58 ± 0.27	3.46 ± 0.06	2.21 ±	-	-	-	0.67 ± 0.00	0.09 ± 0.00	11.3 4	1.41 ± 0.03	-	
Swine manure	300	9.60 ± 0.05 0.1 3	50. 60 ± 0.10	34.87 ± 0.02	3.66 ± 0.18	33.6 8 ± 0.02	2.89 ±	-	-	-	1.26	0.72	1.58 ± 0.03	0.86 1 ± 0.01 9	-	[16]
	500	9.99 ± 0.01 0.2 0	66. 52 ± 0.09	31.59 ± 0.01	1.43 ± 0.01	26.4 8 ± 0.0	1.45 ± 0.01 9	-	-	-	0.54	0.63	7.09 ± 0.07	1.77 2 ± 0.01 4	-	

	700	10.2	68.	30.87	0.68	19.9	0.94	-	-	-	0.26	0.48	24.1	2.11	-	
		6 ±	33	± 0.05	±	3 ±	±						4 ±	0 ±		
		0.06	±		0.00	0.10	0.00						0.16	0.01		
			0.2											6		
			3													
Chicken	300	7.76	-	39.23	-	-	5.78	2.36	0.28	2.92	-	-	102.	4.00	-	[17]
manure									7				73			
Horse	300	8.71	-	60.45	-	-	2.41	1.67	0.12	1.45	-	-	102.	0.31	-	
manure									4				86			
Goat	300	7.24	-	57.18	-	-	0.25	1.57	2.58	0.55	-	-	98.8	1.56	-	
manure							8						0			
Camel	300	8.51	-	54.33	-	-	1.94	0.82	0.15	0.50	-	-	103.	0.32	-	
manure									3				81			
Sheep	300	8.73	-	57.55	-	-	2.27	0.77	0.19	0.34	-	-	96.2	0.19	-	
manure									0				9			
Rabbit	300	8.24	-	56.75	-	-	2.43	0.37	0.17	0.29	-	-	105.	0.27	-	
manure									2				61			

[illegible]

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