

Mechanical Durability and Grindability of Pellets after Torrefaction Process

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Supplementary materials

Table S1. Proximate and ultimate analysis of the investigated raw and torrefied sunflower husk pellet.

Parameter		Temperature		
		Untreated	200 °C	300 °C
Proximate analysis	MC %	1.07 ± 0.11	0.50 ± 0.06	0.92 ± 0.07
	HHV MJ·kg ⁻¹	19.80 ± 0.12	29.98 ± 0.21	29.81 ± 0.03
	AC	3.27 ± 0.12	8.10 ± 0.19	8.50 ± 0.06
	VMC %	77.82 ± 0.31	18.27 ± 0.60	18.93 ± 0.61
	FCC	17.84 ± 0.29	73.13 ± 0.53	71.65 ± 0.72
Ultimate analysis	C	37.0 ± 7.0	74.0 ± 15.0	68.0 ± 14.0
	H	5.9 ± 1.2	3.4 ± 0.7	5.7 ± 1.1
	N %	1.5 ± 0.3	0.88 ± 0.18	1.0 ± 0.2
	O	52.0 ± 10.4	13.5 ± 2.7	16.7 ± 5.4
	S	0.131 ± 0.026	0.075 ± 0.015	0.101 ± 0.020

Table S2. Proximate and ultimate analysis of the investigated raw and torrefied beetroot pomace pellet.

Parameter		Temperature		
		Untreated	200 °C	300 °C
Proximate analysis	MC %	1.03 ± 0.29	0.51 ± 0.09	0.96 ± 0.13
	HHV MJ·kg ⁻¹	17.55 ± 0.07	25.14 ± 0.18	26.08 ± 0.24
	AC	5.87 ± 0.08	13.54 ± 0.47	15.03 ± 0.09
	VMC %	77.96 ± 0.33	31.40 ± 0.25	26.33 ± 0.42
	FCC	15.15 ± 0.15	54.55 ± 0.26	57.67 ± 0.57
Ultimate analysis	C	50.0 ± 12.0	62.0 ± 12.0	53.0 ± 11.0
	H	8.7 ± 1.7	4.1 ± 0.8	3.9 ± 0.8
	N %	1.3 ± 0.3	2.3 ± 0.5	1.5 ± 0.3
	O	24.7 ± 4.9	17.7 ± 3.5	27.0 ± 2.6

S	0.186 ± 0.037	0.288 ± 0.058	0.282 ± 0.056
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Table S3. Proximate and ultimate analysis of the investigated raw and torrefied grass pellet.

Parameter			Temperature		
			Untreated	200 °C	300 °C
Proximate analysis	MC	%	1.16 ± 0.18	0.64 ± 0.12	0.61 ± 0.12
	HHV	MJ·kg ⁻¹	18.63 ± 0.11	25.23 ± 0.10	26.10 ± 0.16
	AC		6.76 ± 0.12	15.75 ± 0.17	17.32 ± 0.30
	VMC	%	76.91 ± 0.53	27.31 ± 0.72	22.60 ± 0.56
	FCC		15.17 ± 0.58	56.30 ± 0.56	59.48 ± 0.73
Ultimate analysis	C		46.0 ± 9.0	66.0 ± 13.0	68.0 ± 14.0
	H		7.0 ± 1.4	3.8 ± 0.8	2.0 ± 0.4
	N	%	1.7 ± 0.3	1.8 ± 0.4	2.0 ± 0.4
	O		38.1 ± 7.6	12.6 ± 2.5	10.2 ± 2.0
	S		0.206 ± 0.041	0.258 ± 0.052	0.285 ± 0.057

Table S4. Proximate and ultimate analysis of the investigated raw and torrefied pine tree pellet.

Parameter			Temperature		
			Untreated	200 °C	300 °C
Proximate analysis	MC	%	0.81 ± 0.18	0.38 ± 0.08	0.47 ± 0.04
	HHV	MJ·kg ⁻¹	20.09 ± 0.02	29.02 ± 0.13	31.97 ± 0.05
	AC		1.06 ± 0.10	6.49 ± 0.26	2.54 ± 0.12
	VMC	%	81.98 ± 0.49	24.29 ± 0.33	15.53 ± 0.35
	FCC		16.15 ± 0.56	68.85 ± 0.50	81.45 ± 0.40
Ultimate analysis	C		49.0 ± 10.0	47.0 ± 9.0	82.0 ± 16.0
	H		7.3 ± 1.5	3.8 ± 0.8	2.1 ± 0.4
	N	%	0.10 ± 0.02	0.50 ± 0.10	0.14 ± 0.03
	O		42.6 ± 8.5	42.9 ± 8.6	13.0 ± 2.6
	S		0.021 ± 0.004	0.085 ± 0.017	0.025 ± 0.005

Table S5. Proximate and ultimate analysis of the investigated raw and torrefied wheat straw pellet.

Parameter			Temperature		
			Untreated	200 °C	300 °C
Proximate analysis	MC	%	1.19 ± 0.12	0.37 ± 0.08	0.81 ± 0.04
	HHV	MJ·kg ⁻¹	18.09 ± 0.14	25.12 ± 0.13	25.25 ± 0.08
	AC		7.54 ± 0.02	19.41 ± 0.07	21.71 ± 0.09
	VMC	%	73.55 ± 0.17	21.39 ± 0.48	16.34 ± 1.55
	FCC		17.71 ± 0.27	58.83 ± 0.47	61.14 ± 1.62
Ultimate analysis	C		44.0 ± 9.0	58.0 ± 12.0	66.0 ± 13.0
	H	%	6.8 ± 1.4	3.4 ± 0.7	1.6 ± 0.3
	N		0.80 ± 0.16	0.80 ± 0.16	0.89 ± 0.18

	O	40.9 ± 8.2	19.1 ± 3.8	10.7 ± 2.1
	S	0.089 ± 0.018	0.117 ± 0.023	0.095 ± 0.019