Effect of Cd on pyrolysis velocity and deoxygenation characteristics of rice straw: Analogized with Cd-impregnated representative biomass components

SUPPLEMENTARY MATERIALS

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The determination of Cd content in Cd-impregnated samples

The Cd-impregnated samples were digested by using HNO_3 and $HClO_4$ according to the methods reported by Zeng et al [1]. The digested solutions were analyzed by inductively coupled plasma-atomic emission spectrometry (ICP-AES, ICAP 7400, Thermo Fisher, USA). The measured content of Cd in Cd-impregnated samples is shown in Table S1.

References:

[1] P. Zeng, Z. Guo, X. Cao, et al. Phytostabilization potential of ornamental plants grown in soil contaminated with cadmium[J] Int. J. Phytoremediat., 2018, 20:311-320.

Table S1. The content of cellulose, hemicellulose, and lignin component in rice straw.

Sample	Cellulose/%	Hemicellulose/%	Lignin/%
Rice straw	39.7	24.8	18.5

Table S2. The measured content of Cd in Cd-impregnated samples.

Samples	CE-5%Cd	XY-5%Cd	LG-5%Cd	RS-0.1%Cd	RS-1%Cd	RS-5%Cd
Content (%)	4.69±0.22	4.92±0.35	4.76±0.29	0.11±0.03	1.17±0.24	4.96±0.31

Table S3. Fitting results based on the isoconversional methods.

Sample	Method		α												
			0.2	0.25	0.3	0.35	0.4	0.45	0.5	0.55	0.6	0.65	0.7	0.75	0.8
CE	KAS	Intercept	18.9	18.4	17.9	17.5	17.2	16.9	16.6	16.3	16.1	15.9	15.6	15.5	15.2
		Slope	-17.6	-17.4	-17.2	-17.0	-16.9	-16.8	-16.7	-16.5	-16.4	-16.4	-16.3	-16.2	-16.1
		R^2	0.9991	0.9988	0.9986	0.9983	0.9982	0.9981	0.9979	0.9977	0.9975	0.9975	0.9973	0.9973	0.9971
	FWO	Intercept	33.7	33.2	32.8	32.4	32.1	31.7	31.5	31.2	31.0	30.8	30.5	30.4	30.1
		Slope	-18.9	-18.7	-18.5	-18.3	-18.2	-18.0	-17.9	-17.8	-17.7	-17.6	-17.5	-17.5	-17.4
		R^2	0.9993	0.9990	0.9989	0.9986	0.9985	0.9984	0.9982	0.9981	0.9979	0.9979	0.9978	0.9978	0.9976
	Friedman	Intercept	25.2	24.9	24.7	24.8	23.9	23.8	23.5	24.0	23.8	23.6	23.5	23.6	23.4
		Slope	-16.2	-16.0	-15.9	-16.0	-15.4	-15.3	-15.2	-15.6	-15.5	-15.4	-15.4	-15.5	-15.6
		R^2	0.9948	0.9940	0.9965	0.9932	0.9962	0.9960	0.9952	0.9934	0.9944	0.9941	0.9961	0.9949	0.9961
CE-5%Cd	KAS	Intercept	45.1	44.3	48.5	46.7	44.9	43.4	41.6	40.0	38.1	36.2	33.9	31.2	27.6
		Slope	-32.2	-32.0	-34.8	-33.9	-33.1	-32.3	-31.4	-30.6	-29.6	-28.6	-27.3	-25.8	-23.8
		R^2	0.6639	0.7117	0.9537	0.9652	0.9740	0.9819	0.9887	0.9948	0.9988	0.9999	0.9952	0.9793	0.9408
	FWO	Intercept	59.9	59.1	63.3	61.5	59.8	58.2	56.4	54.8	52.9	51.1	488	46.0	42.5
		Slope	-33.4	-33.2	-36.0	-35.1	-34.3	-33.5	-32.6	-31.8	-30.8	-29.8	-28.5	-27.0	-25.0
		R^2	0.6823	0.7284	0.9567	0.9676	0.9758	0.9832	0.9896	0.9952	0.9989	0.9999	0.9956	0.9811	0.9463
	Friedman	Intercept	50.9	49.1	51.6	50.8	48.4	45.8	44.6	42.7	40.2	38.2	35.0	32.9	30.4
		Slope	-30.8	-29.9	-31.6	-31.3	-30.0	-28.5	-27.9	-26.9	-25.5	-24.4	-22.6	-21.6	-20.3
		R^2	0.7427	0.8066	0.9874	0.9932	0.9979	0.9986	0.9987	0.9949	0.9869	0.9764	0.9547	0.9190	0.8753
XY	KAS	Intercept	19.2	19.7	20.6	21.9	22.8	25.3	26.5	27.7	29.2	30.7	35.2	57.3	230.0
		Slope	-15.4	-15.8	-16.6	-17.5	-18.3	-19.9	-20.7	-21.6	-22.6	-23.7	-26.6	-40.2	-147.3
		R^2	0.9985	0.9979	0.9972	0.9970	0.9982	0.9997	0.9983	0.9962	0.9926	0.9921	0.9924	0.9448	0.9999
	FWO	Intercept	33.7	34.2	35.2	36.5	37.5	39.9	41.2	42.4	43.9	45.5	50.0	72.0	244.8
		Slope	-16.4	-16.9	-17.7	-18.6	-19.4	-21.0	-21.9	-22.7	-23.8	-24.9	-27.8	-41.4	-148.6

		R^2	0.9989	0.9982	0.9976	0.9974	0.9984	0.9997	0.9984	0.9965	0.9933	0.9928	0.9930	0.9479	0.9999
	Friedman	Intercept	28.0	27.3	33.0	32.5	36.7	40.9	40.4	40.7	42.8	46.1	59.9	96.9	300.9
		Slope	-16.0	-15.8	-19.3	-19.2	-21.7	-24.1	-24.0	-24.3	-25.7	-27.9	-36.4	-59.4	-186.7
		R^2	0.9666	0.9766	0.9406	0.9956	0.9975	0.9989	0.9893	0.9831	0.9813	0.9888	0.9117	0.9259	0.9733
XY-5%Cd	KAS	Intercept	40.4	47.2	49.5	56.0	61.0	68.1	79.8	145.1	231.5	389.8	186.8	167.0	119.0
		Slope	-25.8	-29.7	-31.3	-35.0	-38.1	-42.2	-49.1	-86.0	-137.7	-235.3	-119.9	-111.4	-84.6
		R^2	0.8829	0.9230	0.9063	0.8586	0.8374	0.7951	0.8309	0.7671	0.8504	0.9569	0.8898	0.8773	0.7299
	FWO	Intercept	54.9	61.8	64.1	70.5	75.6	82.7	94.4	159.8	246.2	404.6	201.6	181.9	133.9
		Slope	-26.8	-30.8	-32.3	-36.1	-39.1	-43.3	-50.2	-87.1	-138.8	-236.5	-121.2	-112.7	-85.9
		R^2	0.8910	0.9279	0.9120	0.8661	0.8453	0.8039	0.8374	0.7721	0.8526	0.9573	0.8918	0.8798	0.7366
	Friedman	Intercept	69.0	66.8	58.2	63.2	75.6	82.6	116.0	227.2	351.2	455.1	166.5	145.5	139.4
		Slope	-36.6	-36.0	-31.8	-34.6	-41.5	-45.7	-64.6	-127.3	-201.9	-269.7	-103.5	-93.6	-93.6
		R^2	0.9453	0.9373	0.8133	0.8303	0.8244	0.8019	0.8595	0.8267	0.7699	0.8742	0.8114	0.8063	0.7086
LG	KAS	Intercept	55.3	53.3	52.8	50.8	48.3	47.0	45.9	45.7	46.9	49.6	56.4	72.4	51.1
		Slope	-35.8	-36.0	-36.7	-36.3	-35.5	-35.3	-35.2	-35.7	-37.1	-39.7	-45.2	-57.7	-44.7
		R^2	0.9912	0.9943	0.9966	0.9999	0.9996	0.9989	0.9981	0.9974	0.9975	0.9960	0.9928	0.9318	0.6745
	FWO	Intercept	69.9	68.0	67.6	65.6	63.2	61.9	60.8	60.6	61.8	64.6	71.5	87.5	66.3
		Slope	-36.9	-37.1	-37.9	-37.5	-36.7	-36.5	-36.4	-37.0	-38.4	-41.0	-46.5	-59.1	-46.2
		R^2	0.9917	0.9946	0.9968	0.9999	0.9996	0.9990	0.9982	0.9976	0.9976	0.9963	0.9932	0.9349	0.6907
	Friedman	Intercept	63.8	67.5	60.2	58.2	52.8	53.3	51.6	61.0	52.4	55.7	77.7	89.3	70.9
		Slope	-36.9	-40.1	-36.9	-36.3	-33.6	-34.6	-34.0	-40.7	-35.8	-38.7	-54.6	-64.6	-54.3
		R^2	0.9020	0.9943	0.9922	0.9967	0.9873	0.9957	0.9995	0.9709	0.9866	0.9785	0.9442	0.8405	0.4977
LG-5%Cd	KAS	Intercept	51.1	57.3	60.7	57.8	51.6	47.6	47.6	51.0	64.3	89.6	77.7	77.2	62.2
		Slope	-33.5	-38.3	-41.5	-40.9	-38.0	-36.4	-37.1	-40.2	-50.2	-69.4	-63.5	-65.3	-56.0
		R^2	0.8608	0.9075	0.9630	0.9861	0.9940	0.9961	0.9961	0.9921	0.9879	0.9734	0.9559	0.9916	0.9787
	FWO	Intercept	65.7	72.0	75.4	72.6	66.4	62.5	62.6	66.0	79.4	104.6	92.9	92.4	77.5

		Slope	-34.8	-39.4	-42.7	-42.1	-39.3	-37.6	-38.4	-41.5	-51.6	-70.8	-64.9	-66.8	-57.5
		R^2	0.8688	0.9126	0.9650	0.9869	0.9944	0.9964	0.9964	0.9927	0.9885	0.9744	0.9578	0.9920	0.9798
	Friedman	Intercept	51.3	64.0	68.3	69.4	54.2	52.7	58.1	62.1	81.0	133.6	80.5	57.1	64.0
		Slope	-30.0	-38.2	-41.9	-43.6	-35.2	-34.9	-39.1	-42.6	-56.6	-95.1	-60.4	-45.2	-52.0
		R^2	0.7636	0.9402	0.9168	0.9993	0.9932	0.9951	0.9925	0.9740	0.9879	0.999	0.9778	0.9169	0.9155
RS	KAS	Intercept	22.1	23.8	23.4	23.8	25.9	25.4	24.7	25.2	25.6	24.2	24.8	26.6	26.0
		Slope	-17.7	-19.0	-19.0	-19.5	-20.9	-20.8	-20.6	-21.1	-21.5	-20.8	-21.3	-22.7	-22.7
		R^2	0.9892	0.9930	0.9971	0.9957	0.9886	0.9909	0.9941	0.9911	0.9891	0.9955	0.9911	0.9772	0.9413
	FWO	Intercept	36.8	38.5	38.1	38.6	40.6	40.1	39.5	40.0	40.4	39.0	39.6	41.4	40.8
		Slope	-18.8	-20.1	-20.2	-20.7	-22.1	-22.0	-21.8	-22.3	-22.7	-22.1	-22.6	-23.0	-23.9
		R^2	0.9903	0.9937	0.9974	0.9961	0.9896	0.9917	0.9947	0.9920	0.9901	0.9959	0.9919	0.9793	0.9468
RS-0.1%Cd	KAS	Intercept	25.4	24.2	26.1	26.9	27.5	27.4	26.4	26.8	27.5	28.4	27.7	31.1	25.8
		Slope	-19.6	-19.2	-20.6	-21.3	-21.9	-22.1	-21.7	-22.1	-22.7	-23.4	-23.2	-25.6	-22.6
		R^2	0.9987	0.9978	0.9993	0.9998	0.9993	0.9976	0.9975	0.9918	0.9889	0.9889	0.9937	0.9724	0.9755
	FWO	Intercept	40.1	38.8	40.8	41.6	42.3	42.1	41.2	41.6	42.3	43.2	42.6	46.0	40.7
		Slope	-20.7	-20.3	-21.7	-22.5	-23.1	-23.3	-22.2	-23.3	-23.9	-24.7	-24.5	-26.8	-23.8
		R^2	0.9988	0.9981	0.9994	0.9998	0.9994	0.9978	0.9977	0.9926	0.9899	0.9899	0.9943	0.9749	0.9778
RS-1%Cd	KAS	Intercept	38.6	38.8	37.9	36.9	38.3	38.1	35.5	32.8	32.5	32.1	32.3	33.3	55.8
		Slope	-26.8	-27.3	-27.3	-27.1	-28.3	-28.4	-27.2	-25.8	-25.8	-25.7	-26.0	-26.9	-41.8
		R^2	0.9769	0.9868	0.9881	0.9835	0.9962	0.9998	0.9994	0.9995	0.9999	0.9995	0.9995	0.9963	0.9072
	FWO	Intercept	53.2	53.5	52.6	51.6	53.1	52.8	50.3	47.6	47.4	46.9	47.1	48.2	70.7
		Slope	-27.9	-28.5	-28.4	-28.2	-29.4	-29.6	-28.4	-27.0	-27.0	-26.9	-27.3	-28.2	-43.0
		R^2	0.9787	0.9879	0.9891	0.9849	0.9965	0.9998	0.9994	0.9996	0.9999	0.9993	0.9995	0.9967	0.9124
RS-5%Cd	KAS	Intercept	34.9	36.0	37.8	36.5	36.8	35.0	34.0	33.2	34.4	36.8	38.2	51.5	72.0
		Slope	-24.6	-25.5	-26.9	-26.6	-27.2	-26.5	-26.3	-25.9	-26.8	-28.5	-29.5	-38.3	-53.3
		R^2	0.9657	0.9561	0.9618	0.9770	0.9682	0.9611	0.9594	0.9772	0.9788	0.9844	0.9700	0.9937	0.9825

	Intercept	49.5	50.6	52.5	51.2	51.6	49.7	49.1	48.0	49.3	51.6	53.0	66.3	86.9
FWO	Slope	-25.7	-26.6	-28.1	-27.8	-28.4	-27.6	-27.5	-27.1	-28.0	-29.7	-30.8	-39.5	-54.6
	R^2	0.9684	0.9594	0.9647	0.9788	0.9706	0.9642	0.9626	0.9791	0.9801	0.9855	0.9722	0.9941	0.9833

Table S4. The correlation between pyrolysis conversion (α) and pyrolysis temperature of cellulose, xylan, lignin, and rice straw.

Pyrolysis conversion (α)		0.2	0.25	0.3	0.35	0.4	0.45	0.5	0.55	0.6	0.65	0.7	0.75	0.8
Sample	β/°C·min^{-1}	Pyrolysis temperature/°C												
CE	5	314.8	317.5	319.8	321.8	323.6	325.2	326.8	328.4	330.0	331.5	333.2	335.0	337.0
	10	327.5	330.4	332.9	335.0	337.0	338.8	340.6	342.3	344.0	345.8	347.6	349.6	351.7
	20	340.4	343.6	346.3	348.6	350.7	352.7	354.5	356.4	358.2	360.1	362.0	364.1	366.3
	50	360.3	364.0	367.2	370.1	372.5	374.9	377.1	379.3	381.5	383.6	385.9	388.2	390.8
CE-5%Cd	5	304.7	308.5	311.7	314.7	317.3	319.8	322.2	324.6	326.9	329.3	331.9	334.7	338.3
	10	308.9	313.1	316.9	320.4	323.6	326.6	329.5	332.3	335.1	337.9	340.9	344.1	347.9
	20	307.9	312.7	321.6	325.4	328.9	332.4	335.8	339.3	342.9	346.9	351.5	356.9	364.1
	50	324.9	329.8	334.2	338.0	341.7	345.1	348.5	351.8	355.2	358.7	362.5	366.8	371.9
XY	5	238.2	245.6	253.8	261.8	268.7	274.5	279.6	284.2	288.8	293.8	300.9	316.0	337.8
	10	249.0	256.6	264.4	272.1	278.6	284.3	289.3	294.1	298.5	303.0	308.5	318.1	339.5
	20	260.3	267.5	275.1	282.6	289.5	295.3	300.5	305.1	309.5	314.0	318.9	325.6	341.3
	50	277.8	285.2	292.6	299.7	305.8	309.3	313.5	317.3	320.7	324.7	328.9	334.5	343.6
XY-5%Cd	5	232.2	240.4	246.2	251.6	257.0	262.3	268.8	278.4	294.7	313.9	332.4	351.4	374.9
	10	233.2	242.1	247.9	253.3	258.6	264.0	270.2	278.7	295.7	314.4	335.2	355.4	381.7
	20	244.8	251.7	257.9	263.4	268.3	273.2	278.2	283.7	298.7	315.9	337.8	357.4	383.4
	50	251.5	258.6	263.4	266.6	270.7	274.4	279.8	284.5	299.1	317.0	338.8	359.0	385.0
LG	5	267.6	286.1	301.2	312.6	323.0	332.8	342.7	353.3	364.7	377.5	393.5	416.5	447.4
	10	271.9	291.2	306.4	319.0	329.9	339.9	349.9	360.5	371.9	384.2	398.6	418.4	447.3
	20	277.8	297.1	312.9	325.6	337.1	347.6	358.1	369.0	380.4	392.7	406.6	424.7	451.1
	50	286.2	306.1	321.8	334.4	346.1	356.8	367.4	378.5	389.8	401.7	415.7	434.1	468.6
LG-5%Cd	5	269.4	288.7	305.7	320.5	333.2	345.3	357.8	372.3	390.6	414.2	439.0	462.1	485.9
	10	271.3	291.7	309.8	325.6	339.6	352.2	364.8	378.9	396.3	419.0	444.6	469.0	492.8
	20	275.6	295.6	314.1	330.6	345.3	358.7	371.5	385.0	401.1	422.0	447.4	473.4	497.7
	50	287.8	306.8	324.1	340.4	355.7	369.7	382.7	396.4	411.0	430.1	457.6	481.5	509.8
RS	5	261.9	271.5	279.0	285.5	291.5	297.0	302.0	306.6	310.8	315.3	319.9	325.8	335.1
	10	274.9	283.7	290.8	297.5	303.7	309.1	314.5	319.1	323.7	327.9	332.9	339.5	352.0
	20	286.0	294.5	302.0	308.7	314.5	320.3	325.3	330.3	334.5	339.5	344.5	350.3	361.0
	50	299.3	307.8	316.2	322.6	326.8	333.0	339.3	343.5	347.6	353.9	358.1	362.3	372.6
RS-0.1%Cd	5	264.6	273.6	281.3	288.2	294.7	300.5	305.7	310.5	315.1	319.9	325.1	332.8	335.1
	10	275.1	283.5	291.4	298.0	304.7	310.9	315.9	319.7	324.7	328.9	333.5	338.5	348.4
	20	284.4	293.6	301.1	308.6	315.3	321.9	327.7	332.7	337.7	341.9	346.1	351.9	361.1
	50	299.1	309.7	316.1	322.4	328.6	334.9	341.1	345.3	349.4	353.6	359.9	364.1	372.4
RS-1%Cd	5	270.0	277.9	285.7	293.2	299.6	305.2	309.8	314.0	317.8	321.5	325.7	332.4	352.1
	10	274.6	283.4	291.3	298.7	306.2	312.9	317.9	322.5	326.7	330.4	334.6	340.4	354.1
	20	283.0	291.4	299.8	307.2	314.7	321.3	327.1	332.1	336.3	340.5	344.7	349.7	360.4
	50	294.6	303.1	311.5	319.9	326.2	332.4	338.6	344.8	349.0	353.2	357.4	363.7	372.0
RS-5%Cd	5	261.3	269.5	277.7	285.8	293.6	299.9	305.2	309.6	314.2	319.5	324.2	337.4	365.9
	10	271.1	279.1	287.0	295.3	303.2	310.7	316.2	320.8	325.0	329.1	334.6	344.5	372.9
	20	280.2	288.6	296.1	304.4	312.7	320.2	326.0	330.2	334.4	338.6	343.6	351.9	376.8
	50	287.6	295.2	302.9	312.5	320.2	328.0	333.8	339.7	343.7	347.7	351.7	359.7	383.9

Table S5. Composition of pyrolytic volatiles from rice straw.

Sample	RS	
Number	Components	Relative content/%
1	Alanine	38.37
2	Acetone	23.16
3	3-Pentanone	9.04
4	Acetic acid	8.43
5	Cyclopropyl carbinol	5.56
6	Methyl formate	4.18
7	Cyclohexanone	2.52
8	4-Hydroxy-3-methylacetophenone	2.41
9	n-Hexadecanoic acid	1.17
10	2-Propanone, 1-hydroxy-	0.82
11	9-Octadecenamide, (Z)-	0.46
12	Oleic Acid	0.38
13	9-Octadecen-1-ol, (Z)-	0.37
14	Phenol, 2-methoxy-	0.33
15	Dibutyl phthalate	0.28
16	Heptane, 3-methylene-	0.27
17	Cyclohexane, 2-butyl-1,1,3-trimethyl-	0.27
18	Vanillin	0.26
19	3',5'-Dimethoxyacetophenone	0.24
20	2-Pentadecanone, 6,10,14-trimethyl-	0.23
21	Dibutyl phthalate	0.22
22	Ethanone, 1-(4-hydroxy-3,5-dimethoxyphenyl)-	0.21
23	Docosanoic acid	0.21
24	.beta.-D-Glucopyranose, 1,6-anhydro-	0.17
25	4,8,12,16-Tetramethylheptadecan-4-olide	0.1
26	Cyclododecanol	0.08
27	Cyclohexane, undecyl-	0.08
28	Pentadecanal-	0.06
29	Furan, 2-hexyl-	0.06
30	9-Tricosene, (Z)-	0.06
Sample	RS-0.1%Cd	
Number	Components	Relative amount/%
1	Alanine	52.89
2	Acetone	19.37
3	Cyclopropyl carbinol	9.18
4	4-Hydroxy-3-methylacetophenone	3.8
5	Benzofuran, 2,3-dihydro-	2.38
6	Methyl formate	2.28
7	3-Pentanone	1.77
8	n-Hexadecanoic acid	1.6
9	Phenol, 2-methoxy-	0.9
10	Phenol, 2,6-dimethoxy-	0.68
11	2(5H)-Furanone	0.54

12	9-Octadecen-1-ol, (Z)-	0.47
13	Oleic Acid	0.47
14	1-Dodecanol, 3,7,11-trimethyl-	0.41
15	1,2-Benzenedicarboxylic acid, diundecyl ester	0.39
16	3',5'-Dimethoxyacetophenone	0.37
17	2-Cyclopenten-1-one, 3-ethyl-2-hydroxy-	0.27
18	.beta.-D-Glucopyranose, 1,6-anhydro-	0.27
19	2-Pentadecanone, 6,10,14-trimethyl-	0.27
20	Ethanone, 1-(4-hydroxy-3,5-dimethoxyphenyl)-	0.25
21	4,8,12,16-Tetramethylheptadecan-4-olide	0.21
22	Tetracontane	0.21
23	13-Docosenamide, (Z)-	0.2
24	2-Nonenal, (E)-	0.16
25	Cyclohexane, undecyl-	0.16
26	Dibutyl phthalate	0.14
27	4,8,12,16-Tetramethylheptadecan-4-olide	0.12
28	9-Tricosene, (Z)-	0.1
29	9-Octadecenamide, (Z)-	0.07
30	Tetracosane	0.07

Sample	RS-1%Cd	
Number	Components	Relative amount/%
1	Alanine	43.8
2	Acetone	15.61
3	Cyclopropyl carbinol	8.03
4	Cyclohexanone	4.42
5	4-Hydroxy-3-methylacetophenone	4.07
6	Methyl formate	2.71
7	Benzofuran, 2,3-dihydro-	2.67
8	N,N-Diamylmethylamine	2.24
9	3-Pentanone	1.85
10	Phenol, 2,6-dimethoxy-	1.72
11	.beta.-D-Glucopyranose, 1,6-anhydro-	1.62
12	n-Hexadecanoic acid	1.54
13	2(5H)-Furanone	1.28
14	1,3-Propanediol, 2-ethyl-2-(hydroxymethyl)-	1.09
15	2-Propanone, 1-hydroxy-	0.97
16	Phenol, 2-methoxy-	0.88
17	Acetic acid	0.86
18	Methacrylic acid, ethyl ester	0.78
19	2-Methoxy-6-methylaniline	0.69
20	Oleic Acid	0.47
21	Pentadecanal-	0.41
22	3',5'-Dimethoxyacetophenone	0.33
23	4-Heptanol, 2-methyl-	0.31
24	3',5'-Dihydroxyacetophenone	0.27
25	Phenol, 2,6-dimethoxy-4-(2-propenyl)-	0.25

26	2-Cyclopenten-1-one, 3-ethyl-2-hydroxy-	0.24
27	Ethanone, 1-(4-hydroxy-3,5-dimethoxyphenyl)-	0.24
28	Heptanal	0.22
29	Phenol, 4-ethyl-2-methoxy-	0.22
30	Citronellyl isobutyrate	0.21
Sample	RS-5%Cd	
Number	Components	Relative amount/%
1	Alanine	34.76
2	.beta.-D-Glucopyranose, 1,6-anhydro-	15.27
3	Acetone	13.83
4	N,N-Diamylmethylamine	7.05
5	4-Hydroxy-3-methylacetophenone	3.36
6	Heptanal	3.29
7	Methyl formate	2.68
8	D-erythro-Pentose, 2-deoxy-	2.31
9	Benzofuran, 2,3-dihydro-	2.3
10	Furfural	1.94
11	1,3-Propanediol, 2-(hydroxymethyl)-2-nitro-	1.71
12	Acetic acid	0.95
13	Cyclopropyl carbinol	0.87
14	Ethyl cyclopropanecarboxylate	0.84
15	3-Pentanone	0.83
16	n-Hexadecanoic acid	0.83
17	Pentanedioic acid	0.76
18	Phloroglucitol	0.75
19	1,2-Cyclopentanediol, 3-methyl-	0.72
20	Oxirane, 2,2'-[1,4-butanediylbis(oxymethylene)]bis-	0.69
21	1,2-Cyclopentanedione, 3-methyl-	0.61
22	3-Heptanol	0.53
23	Phenol, 2-methoxy-	0.46
24	2-Propanone, 1-hydroxy-	0.45
25	5-Hydroxymethylfurfural	0.39
26	Phenol, 4-ethyl-2-methoxy-	0.39
27	1,4-Cyclohexanedione	0.38
28	Vanillin	0.38
29	Furaneol	0.34
30	Maltol	0.33

Note: The composition of volatiles was analyzed using PY-GC/MS (EGA/PY-3030D, Frontier, Japan; TRACE 1310/TRACE ISQ, Thermo Scientific, USA).

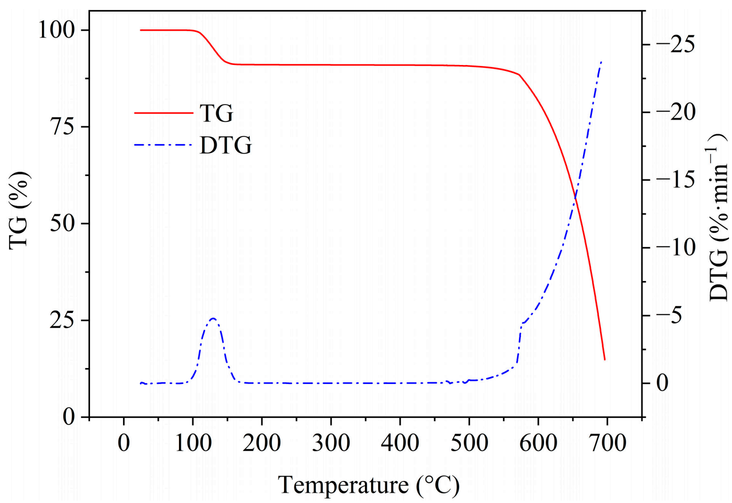

Figure S1. The pyrolysis TG/DTG curves of $CdCl_2 \cdot 2.5H_2O$.

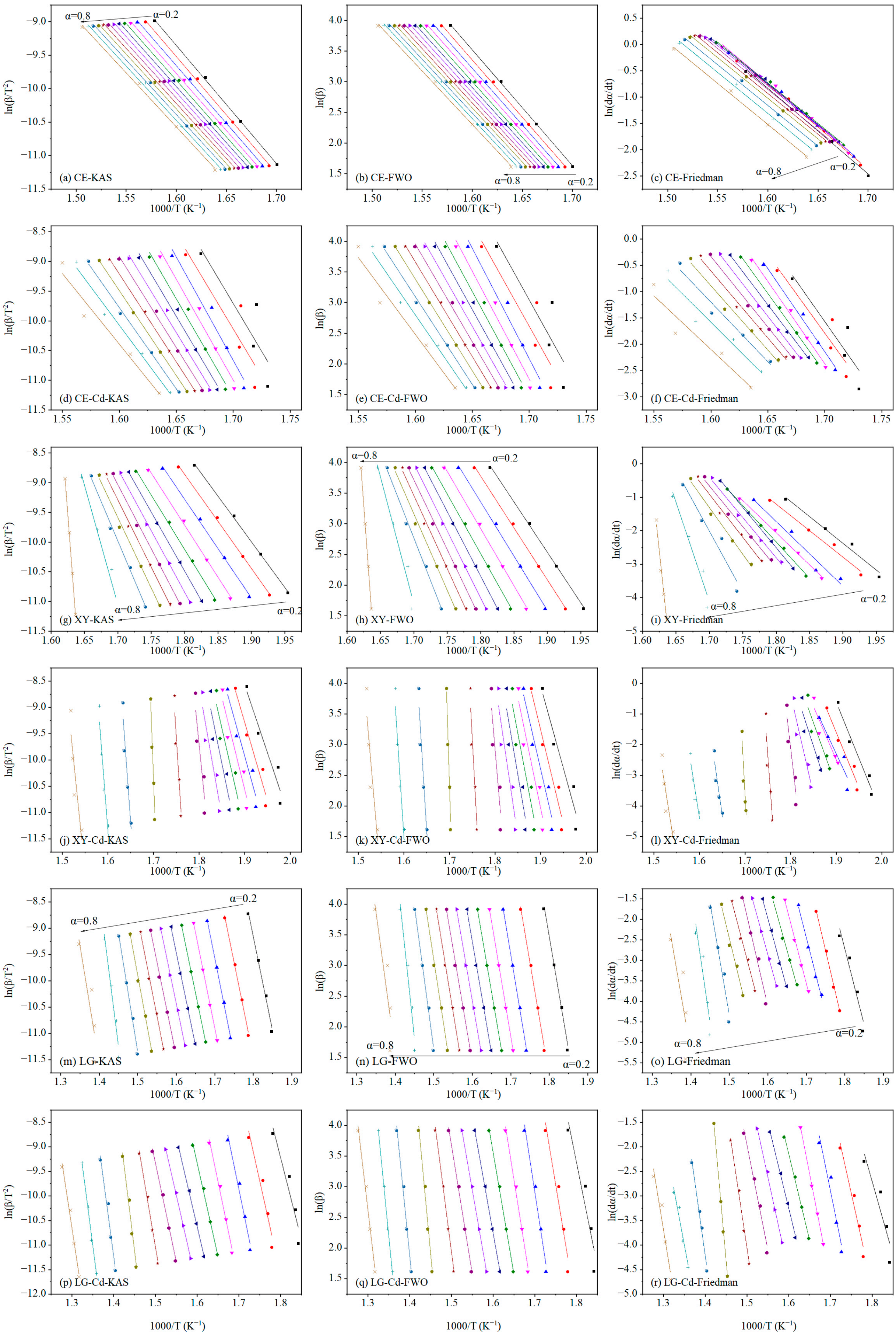

Figure S2. Arrhenius plots of isoconversional method for biomass components samples. (a)-(f) are the CE and CE-5%Cd; (g)-(l) are the XY and XY-5%Cd; (m)-(r) are the LG and LG-5%Cd.

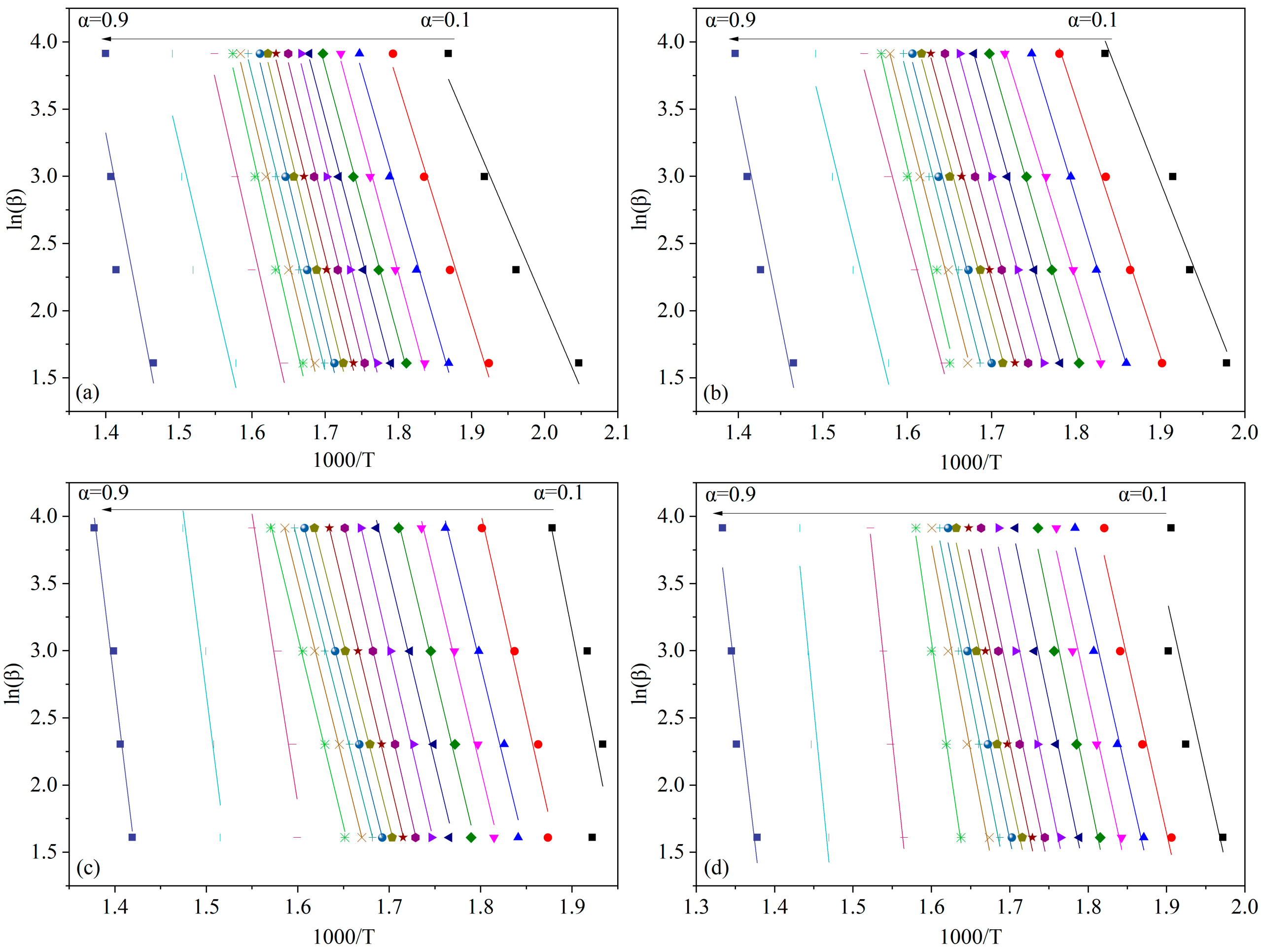

Figure S3. Arrhenius plots of FWO method for Cd-contaminated rice straw. (a) RS, (b) RS-0.1%Cd, (c) RS-1%Cd, and (d) RS-5%Cd.

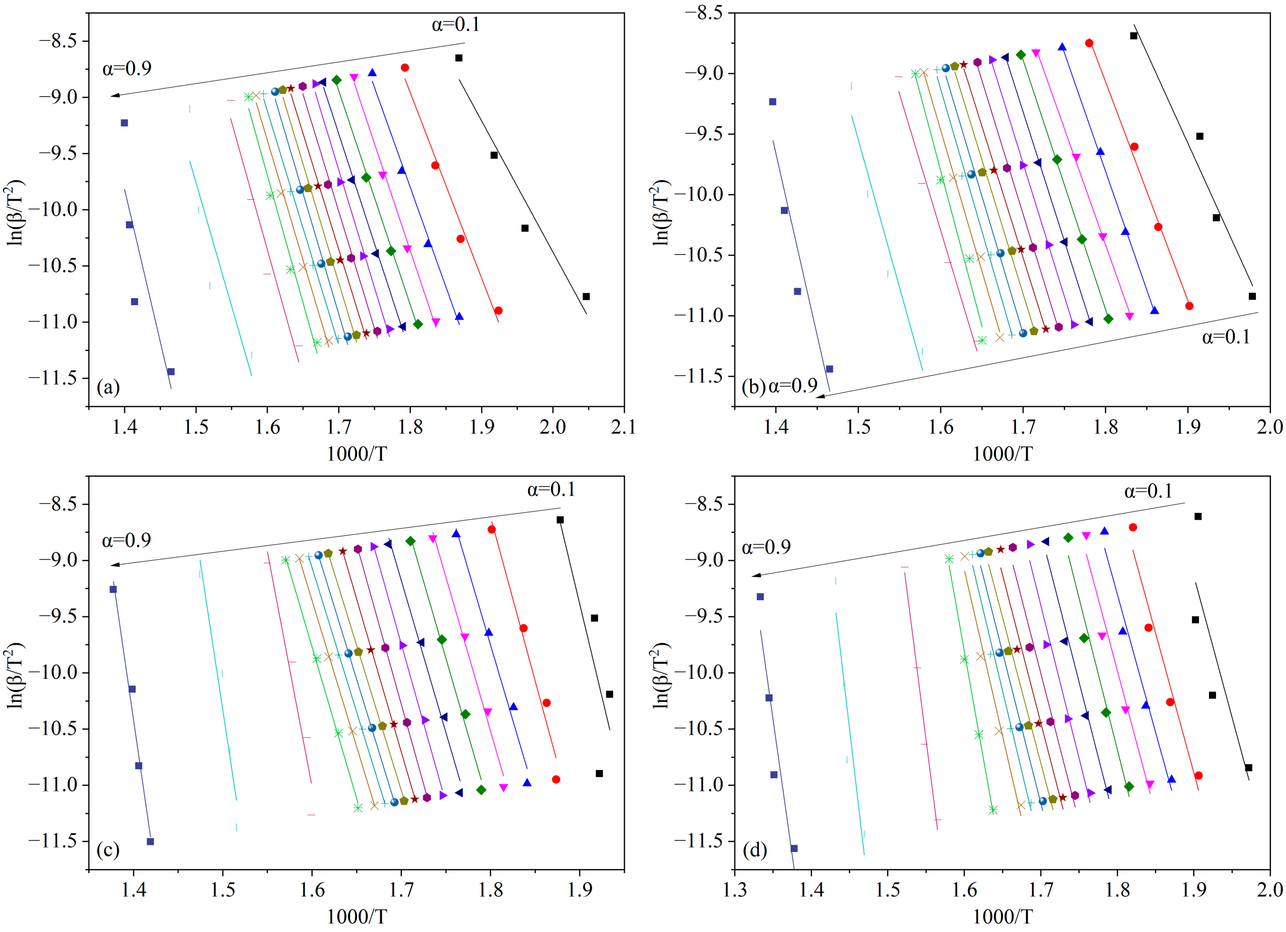

Figure S4. Arrhenius plots of KAS method for Cd-contaminated rice straw. (a) RS, (b) RS-0.1%Cd, (c) RS-1%Cd, and (d) RS-5%Cd.