

Hybrid Raman and laser-induced breakdown spectroscopy for food authentication applications

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Supplementary Material

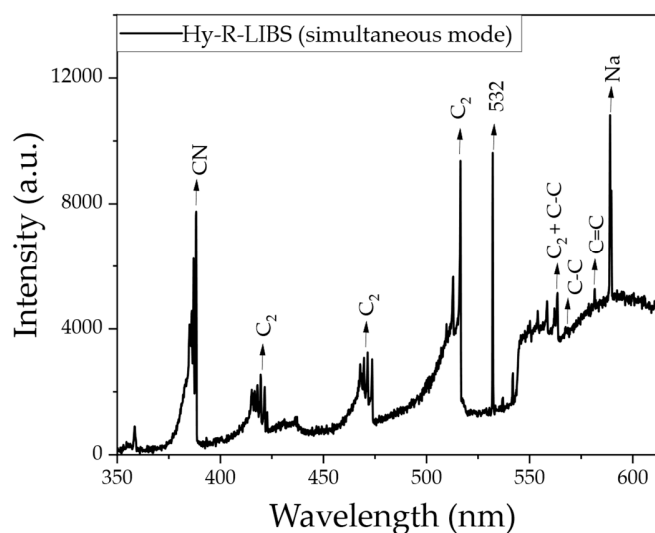
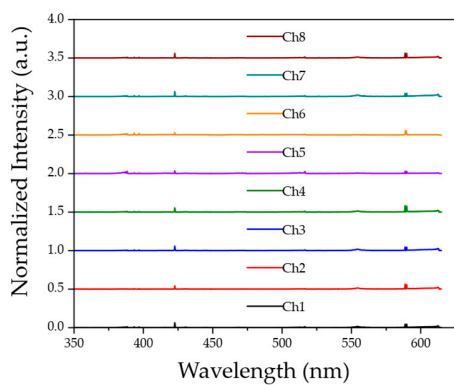


Figure S1. The average of ten simultaneous signals from Hy-R-LIBS system obtained from PS beads.

(a)



(b)

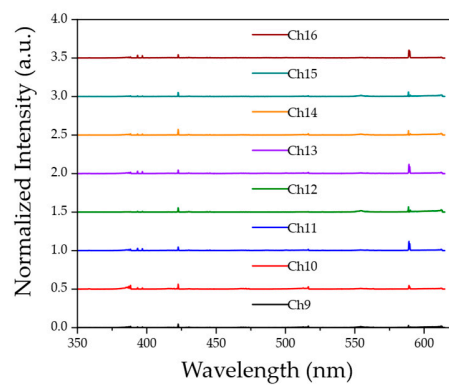
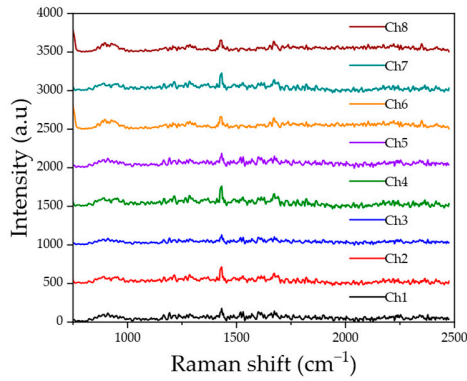


Figure S2. Averaged and normalized spectra of 16 cheese samples using the LIBS system for (a) 8 cheese samples, and (b) 8 other cheese samples.

(a)



(b)

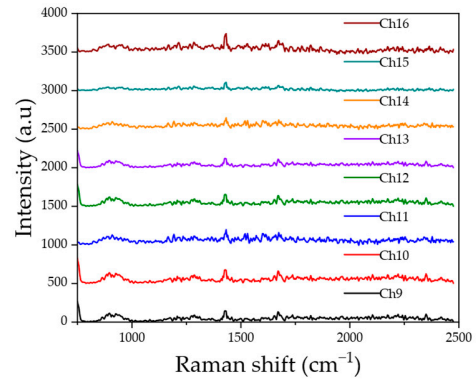
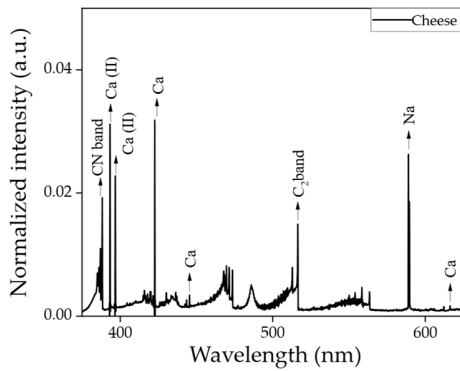


Figure S3. Averaged spectra of 16 cheese samples using the Raman spectroscopy system for (a) 8 cheese samples, and (b) other 8 cheese samples.

(a)



(b)

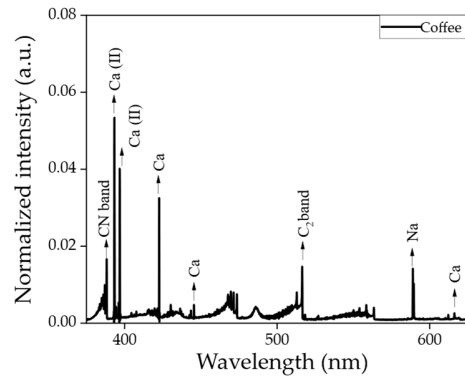
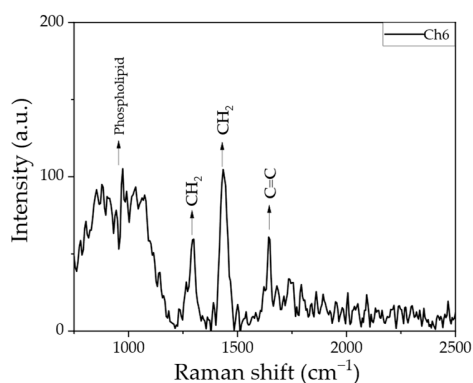


Figure S4. Averaged and normalized LIBS spectra of (a) all 16 cheese samples, and (b) all 7 coffee varieties obtained using a commercially available instrument (Z-900). Note that corresponding spectral range (350-625 nm) was selected.

(a)



(b)

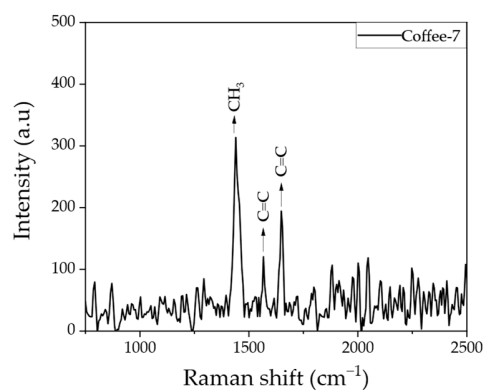


Figure S5. The averaged Raman spectrum for (a) a cheese sample (Ch6), and (b) a coffee sample (C7) collected using a commercially available instrument (Alpha300). Note that corresponding spectral range ($750\text{-}2500\text{ cm}^{-1}$) was selected.

		Target class															
		Ch1	Ch2	Ch3	Ch4	Ch5	Ch6	Ch7	Ch8	Ch9	Ch10	Ch11	Ch12	Ch13	Ch14	Ch15	Ch16
Output class	Ch1	98	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
	Ch2	0	90	0	1	0	0	2	1	1	2	3	0	0	0	0	0
	Ch3	0	0	95	1	0	0	2	0	0	0	1	0	0	0	1	0
	Ch4	2	3	1	88	0	0	0	1	2	2	1	0	0	0	0	0
	Ch5	0	0	2	0	94	1	0	0	1	1	0	0	0	0	0	1
	Ch6	0	0	0	0	1	95	0	0	0	0	0	0	1	2	1	0
	Ch7	0	0	2	3	3	2	84	0	1	0	0	0	1	3	1	0
	Ch8	0	1	0	2	0	1	3	90	1	0	0	0	2	0	0	0
	Ch9	0	0	0	1	0	0	2	2	88	3	0	0	0	1	2	1
	Ch10	0	1	0	1	2	1	1	0	1	86	1	0	1	2	1	2
	Ch11	0	1	0	0	0	0	2	1	0	2	94	0	0	0	0	0
	Ch12	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0
	Ch13	0	2	0	0	0	0	0	3	0	0	0	0	94	0	0	1
	Ch14	0	1	0	2	0	0	2	1	2	0	0	0	0	92	0	0
	Ch15	0	0	0	0	0	0	2	1	0	3	0	0	0	0	94	0
	Ch16	0	1	0	0	0	0	0	0	2	1	0	0	1	0	0	95

Figure S6. An example of a confusion matrix calculated for all the tested cheese varieties using the ENET classifier. Note that this training/testing process was repeated 10 times to produce the results reported in Table 1.

		Target class						
		C1	C2	C3	C4	C5	C6	C7
Output class	C1	93	1	0	0	3	3	0
	C2	4	91	2	0	3	0	0
	C3	0	3	95	0	2	0	0
	C4	0	0	0	100	0	0	0
	C5	2	3	3	0	89	2	1
	C6	1	2	0	0	2	95	0
	C7	0	0	0	0	1	0	99

Figure S7. An example of a confusion matrix calculated for the tested coffee varieties using the ENET classifier. Note that this training/testing process was repeated 10 times to produce the results reported in Table 2.