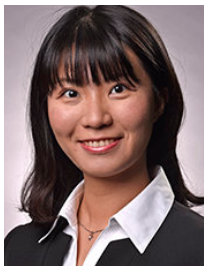
MEASURING ELEMENTS IN TEA WITH HANDHELD LIBS

Application of LIBS in Detecting Beneficial Elements & Contaminants in Tea Samples



Before Covid-19 hit the United States, Dr. Ying Guo, Dr. Seungjin Lee and Dr. Tae Lee from Georgia Gwinnett College began a unique elemental analysis using the SciAps Z-300 handheld LIBS: They tested five popular tea brands to quantitatively determine the amount of both beneficial and contaminant elements in tea commonly available in supermarkets. Since tea is one of the most popular beverages in the world, the GGC team hopes to provide solid advice on the amount of tea that one should drink every day.

Seungjin Lee and Dr. Ying Guo

"By comparing with recommended daily intake limits and reference dose, we'll be able to provide insights on daily consumption limits of tea in order to avoid too much intake of toxic elements," Guo says.

Even though their study was cut short by the shutdown, their initial tests showed that teas that we've come to assume are natural and healthy for consumption actually can contain some hazardous elements that are toxic to the human body. The elements of interest in the study are Ca, C, Mg, Al, K, Sr, Na, Li, P, Si, Cd and Cr. The SciAps handheld LIBS Z-300 was able to identify them all.

Beneficial and contaminant elements

Minerals play an important role in maintaining the human body. For example, Ca helps with the functions of muscle contraction, enzyme activity, healthy bones and teeth, blood clotting, transmission of nerve impulses, and regulating heartbeat. K can help reduce risks for certain diseases such as stroke, kidney stones, and hypertension. Even though those are beneficial elements to the human body, there is still a suggested daily intake limit.

Additionally, tea may be contaminated by heavy metals, "either as a result of uptake from soil or from atmospheric dispersion due to vehicular or human activities," Guo states. This is what led them to investigate the levels of both the beneficial minerals (e.g., potassium and calcium) and unwanted contaminant elements (e.g., cadmium and chromium) present in different tea brands. Heavy metals can be highly toxic even at a very low concentration. LIBS was able to detect the presence of these metals in all five samples.

The acceptable levels of these elements for human consumption was used for comparison.

Element	Recommended Daily Intake
Ca	1300 mg/day [1]
Mg	320 – 420 mg for adult depending on age [2]
K	4700 mg/day [1]
Na	Less than 2300 mg/day [1]
	[1] https://www.fda.gov/food/new-nutrition-facts-label/daily-value-new-nutrition-and-supplement-facts-labels [2] https://ods.od.nih.gov/factsheets/Magnesium-HealthProfessional/

Element	Reference Dose (RfD) or Secondary Maximum Contaminant Level
Al	The EPA has recommended a Secondary Maximum Contaminant Level (SMCL) of 0.05–0.2 mg/L for aluminum in drinking water. The SMCL is not based on levels that will affect humans or animals. It is based on taste, smell, or color. [3]
Cd	Oral "water" RfD for cadmium for use in assessment of risks to water of 0.0005 mg/kg-day. Oral "food" RfD for cadmium for use in assessment of risks to soil and biota of 0.001 mg/kg-day. [4]
Cr	The Maximum Contaminant Level (MCL) of 0.1 mg/L including both Cr(VI) and Cr(III). [5]
	[3] https://www.atsdr.cdc.gov/phs/phs.asp?id=1076tid=34#:~:text=OSHA%20set%20a%20legal%20limit,an%208%20hour%20work%20day [4] https://www.atsdr.cdc.gov/csem/csem.asp?csem=6&po=7 [5] https://www.epa.gov/risk/regional-screening-levels-rsls-users-guide#chromium

Elements in the daily cup

The GGC team pelletized the tea grains from each tea brand. The intensities of emission spectra at different wavelengths were measured to determine the presence of elements of interest in the samples. Results were validated by inductively coupled plasma mass spectroscopy.

The results provide insights on daily consumption limit of tea to avoid too much intake of toxic elements.

In short, the three elements with the highest relative abundance are Ca, C, and Mg in all the five tea samples studied. Depending on the brand, the elements with lower relative abundance vary. They include Al, K, Sr, Na, Li, P and Si. Peaks for Cd and Cr are also observed in all five tea samples, though with a much lower relative abundance.

The study is not complete, but the authors are preparing for the next steps.

"(Before the shutdown), we obtained the spectra of tea samples and were able to qualitatively determine the elements present," Guo says. The next step will be to calibrate and complete the quantitative analysis.

We look forward to the GGC team continuing with their work when it is safe for them to go back to the lab.

Tea Samples	Element	Relative Abundance	Likelihood	Lines %
Tetley Black Tea Classic Blend	Ca	54.3	100	180
	C	25.9	100	37.1
	Mg	5.67	72.7	33.3
	Al	5.44	66.7	27.2
	K	2.36	100	1.42
	Sr	2.32	100	8.73
	Na	1.76	100	5.53
	Li	1.63	100	0.491
	P	0.464	66.7	1.89
	Si	0.178	50	0.669
Twingings of London English Breakfast Black Tea	Ca	56.4	100	161
	C	29	100	37.5
	Mg	5.01	72.7	23.4
	Al	3.74	50	26
	Sr	1.82	100	5.79
	Na	1.75	100	4.63
	K	1.61	50	0.818
	P	0.464	66.7	1.42
	Si	0.214	50	0.68
Lipton Organic Black Tea	Ca	58.4	100	161
	C	24.4	100	24
	Mg	4.85	72.7	23.4
	Na	3.07	100	8.07
	K	2.54	100	1.26
	Al	2.43	50	17.4
	Sr	1.89	100	5.88
	Li	1.85	100	0.459
	P	0.507	66.7	1.51
Tazo Awake English Breakfast Black Tea	Ca	59.5	100	165
	C	23.6	100	26.3
	Mg	6.26	81.8	34.4
	K	3.41	100	1.82
	Al	2.45	50	16.7
	Li	1.75	100	0.467
	Na	1.57	100	4.53
	Sr	0.938	100	3.12
	P	0.466	66.7	1.49
Newman's Own Organic Black Tea	Ca	62.7	100	168
	C	24.7	100	20.2
	Mg	5.15	72.7	20.7
	Sr	1.97	100	5.37
	Al	1.53	50	8.44
	K	1.33	50	0.584
	Li	1.15	100	0.251
	Na	1.11	100	2.57