SPEX®

ANALYSIS OF GOURMET SALTS FOR THE PRESENCE OF HEAVY METALS

ABSTRACT

Salt has been a common commodity and household staple for thousands of years. Over the past decade salt has transformed from a common product into a gourmet item with various origins and processing methods, representing all the colors and flavors of the gourmet spice market. Gourmet salt sales exceed $250 million per year. Some exotic varieties are luxury products retailing for more than $20 per ounce compared to regular table salt at $0.02 per ounce.

This study examined a variety of gourmet salts for the elemental composition and for the presence of heavy metals. The salt samples represented many different colors, production methods, textures, and price points.

1. SAMPLES AND ANALYTICAL METHOD

Sample Preparation

Twelve gourmet salt products were purchased from various New Jersey supermarkets. In addition to the gourmet salts, table salt and reagent grade sodium chloride were tested for comparison.

0.13 to 0.15 g of sample were dissolved in 50 mL water with 2% Nitric Acid.

Analytical Conditions

- Instrument: DRC ICP-MS
- Instrument conditions:
  - RF Generator: 1000W
  - Plasma Gas Flow: 15 L/min
  - Aux. Gas Flow: 1 L/min

SPEX APPLICATION NOTE

Table 1. Salt samples used in the study.

Sample #	Name	Location	Source	Color	Appearance	Odor
1	Reagent Grade NaCl	USA	Mineral Deposit	White	Very Fine Crystals	None
2	Cyprus Black	Mediterranean Sea	Sea Salt	Dark Grey, Black	Extra Large, 2-10 mm Crystal Flakes	None
3	Mediterranean Sea Salt	Mediterranean Sea	Sea Salt	White	Large Crystals, 2-3 mm	None
4	Sel Gris De Guerande	France	Sea Salt	Light Grey	Irregular Small Crystals, 1-3 mm	Slightly Smoky Odor
5	Alaea Hawaiian Sea Salt	Hawaii	Sea Salt	Red Brown	Large Crystals, 2-3 mm, Damp	Slightly Earthy Clay Odor
6	Hawaii Kai Black Salt	Hawaii	Sea Salt	Black	Irregular Crystals, 1-3 mm	None
7	Murray River Pink Flake Salt (Plastic Container)	Australia	River Salt	Light Pink/ Beige	Small, < 2 mm Flakes	None
8	Primordial Himalayan Salt	Himalayas	Mineral Deposit	Varied Pink/ White	Large Crystals, 2-10 mm	None
9	Sel de Mer	Israel	Sea Salt	White	Large Crystals, 3-5 mm	Slight Metallic Odor
10	Murray River Pink Flake Salt (Glass Container)	Australia	River Salt	Light Pink/ Beige	Small, < 2 mm Flakes	None
11	Kala Namak Black Mineral Salt	India	Mineral Deposit	Light Brown with Black Specks	Fine Powder	Slight Sulfur Odor
12	Fumee de Sel Chardonnay Oak Smoked Salt	France	Sea Salt	Sooty Grey/ Brown	Clumping Damp Irregular Small Crystals	Strong Charred Wood Odor
13	Himalayan Pink Fine Mineral Salt	Himalayas	Mineral Deposit	Light Pink/ White	Very Fine Crystals	Slight Earthy Odor
14	Table Salt (Non-Iodized)	USA	Mineral Deposit	White	Very Fine Crystals	None

2. RESULTS

Macro Elements

The highest concentrations of macro elements such as calcium, iron, potassium, magnesium, and phosphorus were found in the darker colored salts, primarily in the black salts. Calcium levels over 1,000 µg/g were all detected in the grey or black salts. Ordinary table salt had a calcium level of 218 µg/g. Iron levels ranged from 2 to 500 µg/g with the highest level of 518 µg/g in the Kala Namak Black Mineral Salt (#11). The next highest iron concentration (72 µg/g) found in the Sel Gris de Guerande salt (#4) was about seven times less than sample #11. Potassium levels in sample #11 exceeded 29,000 µg/g compared to potassium levels in table salt of 1,000 µg/g. Magnesium levels in table salt were measured at 5 µg/g. The Oak Smoked Salt (#12) contained magnesium levels (8,600 µg/g) over 1,000 times the levels found in table salt.

Table 2. Comparison of macro elements in table salt, NaCl reagent and notable samples.

Element	Table Salt	NaCl Reagent	Min (µg/g)	Max (µg/g)	Sample with the Highest Concentration
Ca	218	4.7	73	1,400	4 & 2 (equal)
Cu	0.03	0.02	0.02	1.2	11
Fe	2.3	0.11	2.4	510	11
K	1,000	52	600	29,000	11
Mg	5.3	0.98	35	8,600	12
Mn	0.33	0.45	Not Detected	22	11
P	56	120	Not Detected	380	6
Se	Not Detected	1.1	Not Detected	3	12
Zn	0.2	Not Detected	Not Detected	3.5	11

Toxic Elements

Small concentrations of toxic elements (< 3 µg/g) were found in the gourmet salts tested. Negligible amounts of arsenic, cadmium and mercury were detected. The highest elemental concentrations of toxic elements were found in the darker colored salts. The chromium levels of 2.6 µg/g were found in the Alaea Hawaiian Sea Salt (#5) and Mediterranean Sea Salt (#3). These maximum levels of chromium were very close to the chromium levels found in table salt at 2 µg/g. Lead levels in the majority of the salts tested ranged around 0.5 µg/g. Four of the black or grey salts contained around 1 µg/g of lead. The highest concentration of lead (1.3 µg/g) was found in sample #4. Lead levels in table salt were 0.44 µg/g. Thallium levels in most of the salts were < 1 µg/g with the exception of three black and grey salts with over 1 µg/g of thallium. Vanadium was virtually undetected in all but one salt, sample #11, which contained 1.9 µg/g.

Table 3. Comparison of toxic elements in table salt, NaCl reagent and notable samples.

Element	Table Salt	NaCl Reagent	Min (µg/g)	Max (µg/g)	Sample with the Highest Concentration
As	Not Detected	Not Detected	Not Detected	0.1	11
Cd	Not Detected	Not Detected	Not Detected	0.093	13
Cr	2	0.52	0.11	2.6	5 & 3 (equal)
Hg	Not Detected	Not Detected	Not Detected	0.18	11
Ni	2	0.54	Not Detected	3.6	13 & 3 (equal)
Pb	0.44	0.39	0.4	1.3	4
Tl	0.84	0.63	Not Detected	1.6	6 & 12 (equal)
V	Not Detected	Not Detected	Not Detected	1.9	11

3. CONCLUSIONS

This study shows that the highest concentration of elements were found in the darker or deeply colored salts. The Kala Namak Black Mineral Salt (#11) had the highest concentration of arsenic, mercury, vanadium, potassium, zinc, and iron. The reagent grade NaCl and generic table salt contained the least amounts of the elements examined.

4. ADDITIONAL RESOURCES

To watch our webinar on Toxic Metals in Gourmet Foods, an analysis of trace metals in common gourmet foods including salt, chocolate and fish, visit our YouTube channel at www.youtube.com/spexcertiprep.