Trace elements concentration distributions in breast, lung and intestine tissues determined by TXRF analysis

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Background DL $\propto I_{\text{Background}}$

characteristic X-rays

detector

primary beam

sample

sample backing

total external reflection effect

drastically lower background $I_B$

$c_{DL} \sim 10^{-9} \text{g/g}$
- X-ray tube (3kW, Mo anode 20-55kV, 5-60mA)
- Si(Li) detectors
- ACCUSPEC+
- AXIL+QAES

**Advantages of X-Ray Fluorescence method**

- multielemental
- fast
- wide range of measured concentration: ppb - 100%
Several elements play a crucial role in carcinogenesis:

- **Cu** and **Zn**
  - take part in the metabolism of carbohydrates, lipids, proteins, in the synthesis and degradation of nucleic acids
  - are cofactors of enzyme which prevents the start and progression of tumours

- **Se**
  - is integral part of enzyme that protects the tissue against oxidation, and antagonizes toxic effect of heavy metals
  - may alter the carcinogen metabolism and protect DNA against carcinogen induced damage.

- **Fe**
  - it is well known that it takes part in carcinogenic process
  - cancer cells usually need enhanced supply of Fe
Material & experimental procedure

Breast: 68 patients with benign, 26 one with malignant tumour,
Lung: 13 samples of benign neoplasm, 69 - cancerous tissue,
Intestine: 42 patients with benign colon polyps and 73 with cancer.

ضبط 0.5g of tissue +1.5ml of HNO₃ +
+100μl water solution Y(NO₃)
ضبط mineralization in microwave
ضبط 1-2μl drop of solution into backing
ضبط infrared drying
ضبط measurements of X-ray spectrum
ضبط spectrum analysis
ضبط calculation of element concentration in
solution
ضبط substraction of solution contamination
ضبط data conversion into mass of sample
concentration measured $\Rightarrow$ concentration below the detection limit of the method used.

**distribution of concentrations**
$c_1 < c_2 < c_3 < ... < c_n$

Kaplan-Meier method

**complication in estimation of mean concentration & in statistical analysis**

distribution of detection limit values
$c_1^{DL} < c_2^{DL} < c_3^{DL} < ... < c_n^{DL}$

Next step of statistical analysis: logrank test to testing distributions (censored as well as uncensored) describing 2 studied populations.

**distributions:**
- $n(c)$-censored
- $m(c)$-detection limit
- $N(c)$-original (reconstructed)
The same organ - different neoplasm

Results & discussion

cancerous – benign tissue:

**breast:**
- Fe: 23.6 -13.3,
- Se: 0.156 - 0.103,
- Se/Zn: 0.033 - 0.021

**lung:**
- Cu: 2.72 - 5.90,
- Zn: 11.7 - 21.2,
- Se/Zn: 0.061 - 0.040

**intestine:**
- Zn: 14.8 - 9.65,
- Cu/Zn: 0.274 - 0.472

Statistically significant differences

breast:
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Log-rank test:
- \( \chi^2 = 7.1 \)
- \( \chi^2_{\text{crit}} (99.5\%) = 7.88 \)
Results & discussion

Cu, Fe, Zn, Se:

**benign tissue:** breast – intestine
breast – lung

cancerous tissue: breast – intestine, breast - lung

Fe, Cu:
cancerous tissue: lung – intestine

Zn:

**benign tissue:** lung - intestine

cumulative distribution function (cdf)

Fe, Cu:
cancerous tissue: lung – intestine

Zn:

**benign tissue:** lung - intestine

Statistically significant differences

Kaplan-Meier method:
censoring mean median level value (ppm)
0% 13.3  8.63
0% 43.1  43.5

log-rank test:
$\chi^2 = 67$
$\chi^2_{crit}(99.5\%) = 7.88$

Kaplan-Meier method:
censoring mean median level value (ppm)

Fe
benign tissue

N = 10 samples
N = 68 samples

Kaplan-Meier method:
censoring mean median level value (ppm)
0% 13.3  8.63
0% 43.1  43.5

log-rank test:
$\chi^2 = 67$
$\chi^2_{crit}(99.5\%) = 7.88$

Se

N = 69 samples
N = 26 samples

Kaplan-Meier method:
censoring mean median level value (ppm)

breast: 31 %  0.156  0.144
lung:  12 %  0.652  0.530

log-rank test:
$\chi^2 = 58$
$\chi^2_{crit}(99.5\%) = 7.88$
Thank You for Your attention