Elemental Analysis of Colorectal Cancerous Samples using XRF Techniques

A Biophysics Project for SESAME
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Al Balqa Applied University Salt Jordan

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Plan

- Introduction
- Motivations
- XRF Techniques
- Main Results
- *SESAME* Perspectives

Introduction

There are at least about 40 chemical elements in the living organisms of a human body.
These elements can be grouped into three groups:

- ❖The major group comprising
  H, C, N, O (~96.6%)
- ❖The Trace elements group :

Na, Mg, P, S, Cl, K, Ca , Fe, Mn, Co, Zn and Ni (< 5%)

- ❖A minor group of trace elements :

  V, Mo, Li, F, Si, As, Br, Sn, I and Ba (0.001%) .

Motivations
Cancer and Nutrition Systems
A major problem

Several case-control studies did investigate the Correlation between the consumption of certain elements and certain types of cancer (Iron and colorectal cancer, Calcium and Colorectal and Breast cancers) BUT NO MEASUREMENTS WERE DONE

Motivations

1. Studies on the level of elemental concentrations in cancerous organs studies are rare in literature.
2. Need to measure elements' concentrations in cancer

   Statistical studies about the possible correlation between some elements and cancer exist but no estimation
3. Some cancer types (colorectal, stomach) are proved through **case-control studies** to be related to the nutrition systems. The incidence rate of colorectal cancer is 20 times higher in the rich countries than in the poor ones (Because of food richer in fat)

XRF Techniques

X-ray Fluorescence (XRF) is an efficient, non-destructive and powerful elemental analysis technique.

XRF is a fingerprinting method of a sample's elemental components

Basic Idea

1. A sample is irradiated using an excitation source,
2. The X-ray spectrum of the sample, called ***the fluorescence spectrum*** is collected,
3. The XRF spectrum is constructed

using one or both of two methods:

a) The Energy Dispersive XRF (or EDXRF) or

b) The Wave Dispersive XRF (or WDXRF)

4. The concentration of an element in the sample is related to the corresponding intensity. Concentrations down to the level of ppm can be obtained with 10% accuracy

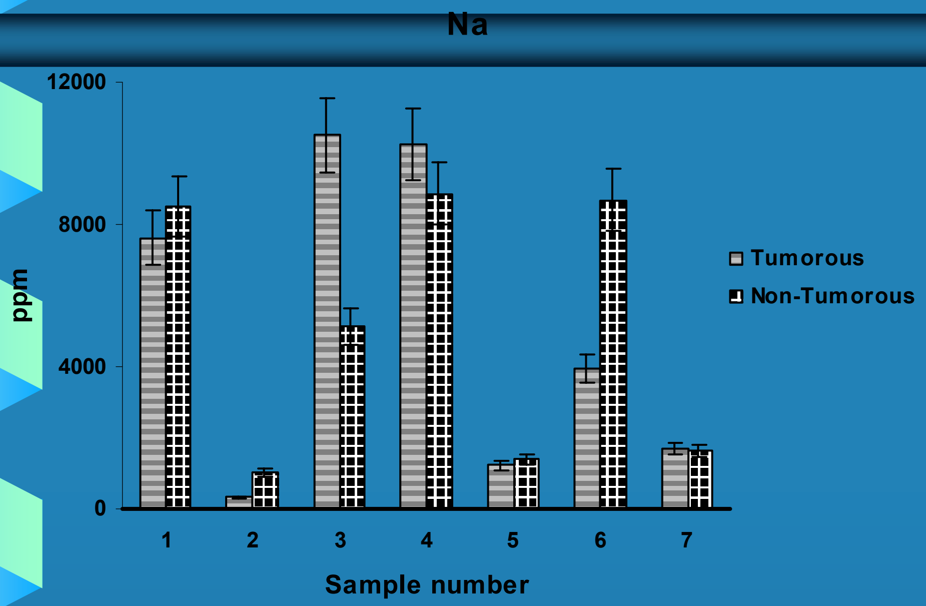
Results

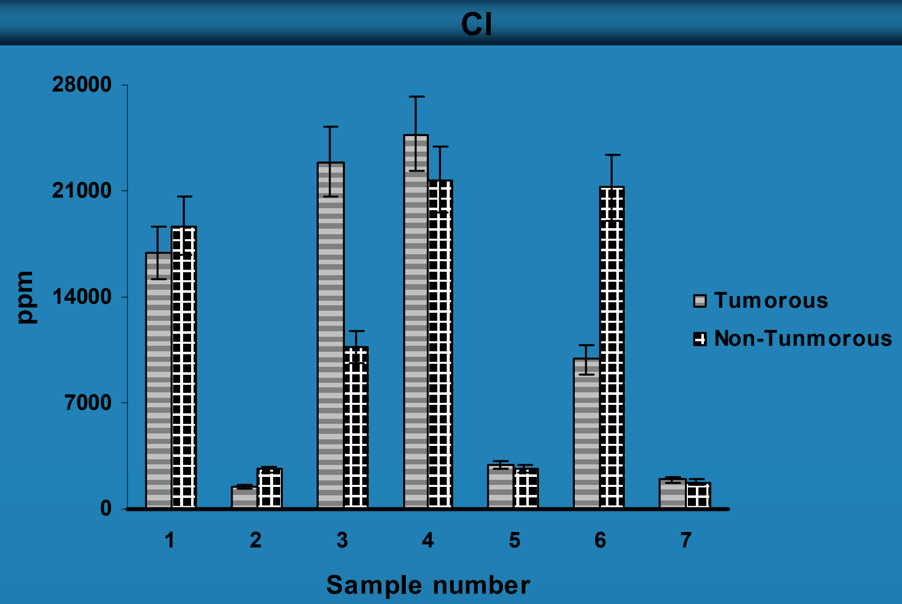
- Comparison of the concentrations of elements in the cancerous part of (seven) colorectal samples and the corresponding adjacent non-cancerous part

- A classical XRF Spectrometer (The Oxford ED2000) is used. EDXRF is used here.

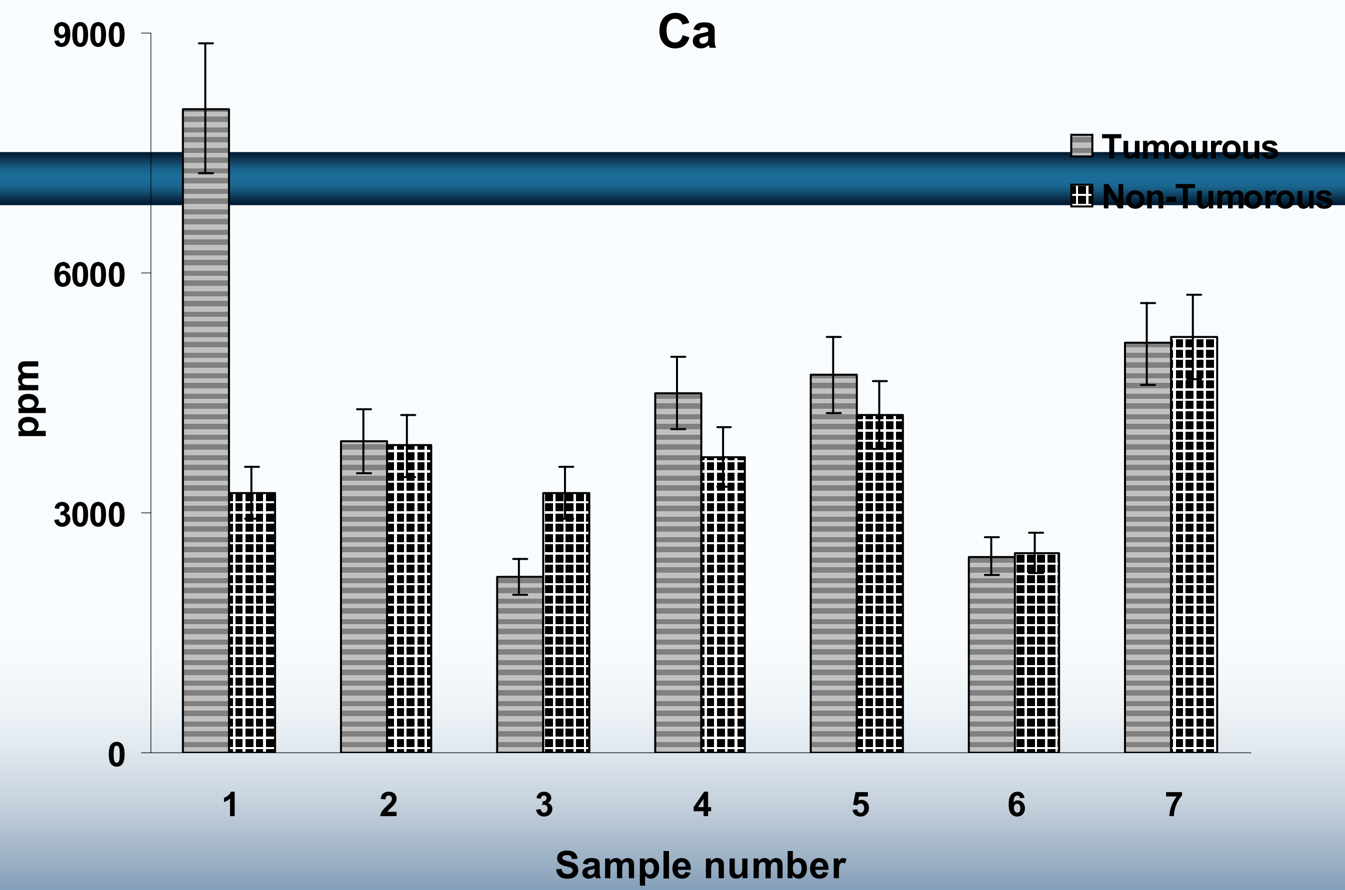
High Concentration Group

Elements with concentrations higher than 1000 ppm (1%) : (sodium, sulfur, chlorine and calcium)

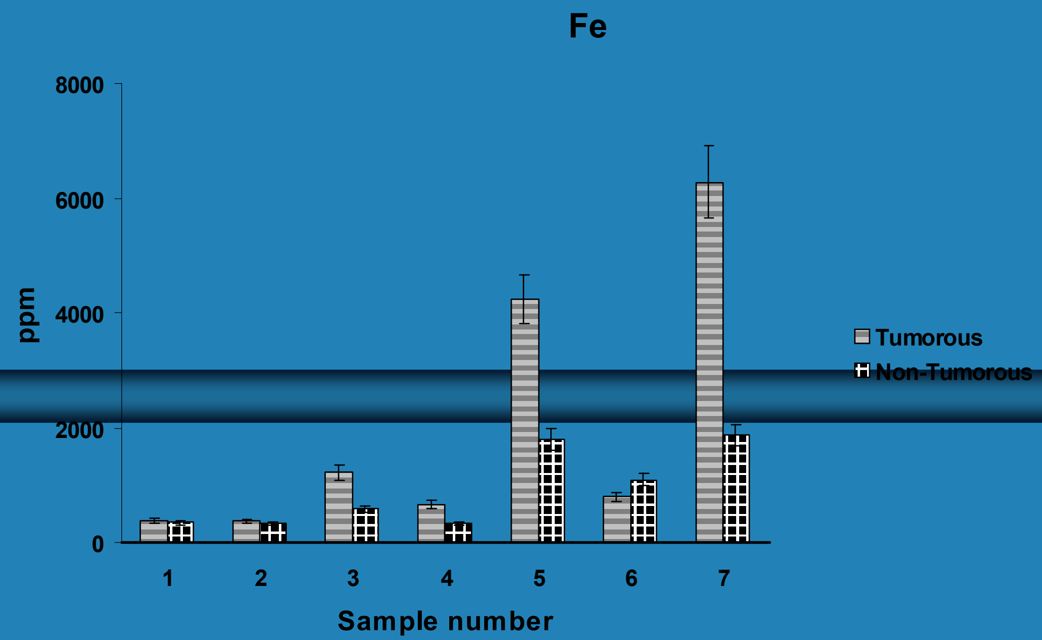


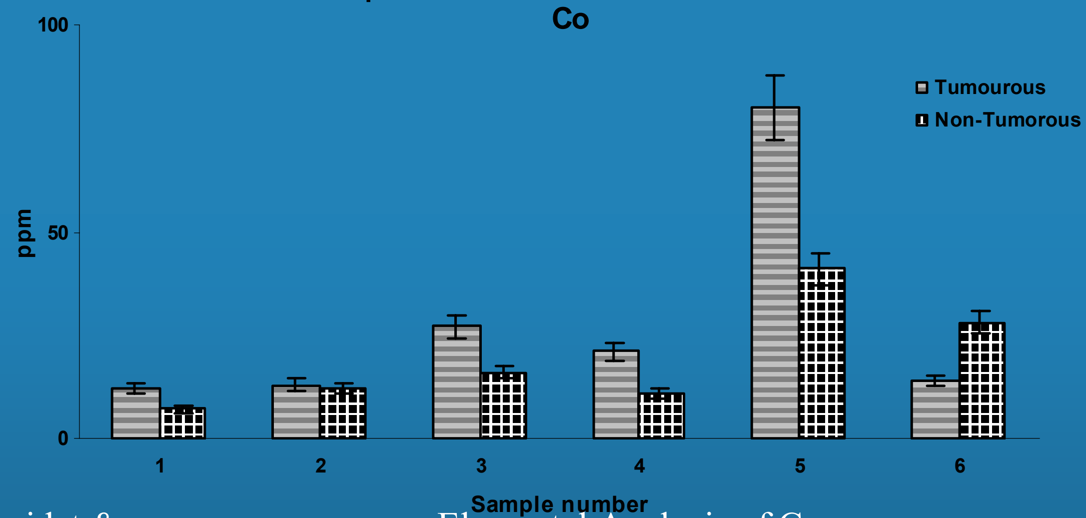


High Concentration Group
(Na, Cl, Ca and S)



Fe & Co


Fe
8000
6000
4000
2000
0
ppm
1
2
3
4
5
6
7
Sample number
Tumorous
Non-Tumorous


Co
100
50
0
ppm
1
2
3
4
5
6
Sample number
Tumourous
Non-Tumorous

Major Conclusions

1. Sodium and Chlorine tend to be higher in the cancerous parts in the case of the elderly persons than the younger patients. The ratio Cl to Na varies in the range 0.36 to 0.53.

Sodium is the principle factor for carbohydrate absorption in the intestines and the sodium chloride is known to play an important role in hypertension. Does it also have an importance in cancer?

2. Iron and cobalt tend to increase in the cancerous parts. The ratio cobalt to iron is almost constant and equals 3%. Extra iron is known to be toxic for the human body. Our study suggests that it could also play a role in cancer.
3. Finally, the other elements, such as phosphorous, sulfur, or zinc do not exhibit any peculiar behavior between the CP and the NCP.

SESAME PERSPECTIVES (1)

1. The excitation sources (PIXE, X-Ray Tubes) used in this type of studies are limited in energy. SESAME will provide ***THE SOURCE***
2. The noise to signal ratio is expected to be reduced and controlled.
3. With the right detector, a better elemental analysis can be done especially for the low Z elements. Research in the detection techniques should accompany this research

SESAME PERSPECTIVES (2)

4. A Comparison with colorectal samples coming from other regions would allow to see the correlation with the nutrition system. We are working on the comparison with samples coming from Egypt.

Towards a multidisciplinary Jordanian team for SESAME

1. This research interests many jordanian scientists from different disciplines (Physicists, Chemists and Biologists).

A Team at Yarmouk University is hoped to be formed soon and to be announced at a future SESAME meeting

Thank U

A Biophysics Project for SESAME

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