



# Investigations into the Trace element variations in Wheat grains by Hand held X-ray Fluorescence

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## Abstract

Wheat of different genotypes was analyzed for their micro and macronutrient contents using HHXRF. It was found that K and Ca was present in significant quantities and besides other trace elements Fe and Zn were present showing a positive trend for crop improvement programme.

**Keywords:** wheat, micronutrients, HHXRF, trace elements, crop

## 1. Introduction

Wheat of different genotypes was analyzed for their micro and macronutrient contents using Hand held X-ray Fluorescence (HHXRF). It was found that K and Ca was present in significant quantities and besides other trace elements like Fe and Zn were present showing a positive trend for crop improvement program. Since wheat is Indian staple food, the objective was to find the Fe and Zn content in each of these genotypes to have high yielding nutritionally superior genotypes.

Five different genotypes of wheat whole wheat, machine powdered and finely powdered by pestle and mortar were analyzed for the trace elemental contents for comparison using HHXRF.

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## 1. Experimental Techniques

Hand held XRF (HHXRF) is the need of the hour to analyze metals, powders and alloys, as other conventional XRF techniques are found to be cumbersome and difficult to handle. So, to test the efficiency of the HHXRF on wheat powder, a test sample was analyzed to detect the trace elements. The wheat powder was obtained from the Nuclear Agriculture and Biotechnology Division, BARC. The sample was powdered finely and was placed in a cubical box for irradiation by X-ray tube. Rhodium tube was used for irradiation. The spectrum was obtained in 20 seconds.

## 2. Figures and Tables

A Typical spectrum of the dental powder is shown in Figure 1. The prominent peaks of K (3.3 keV) and Ca (3.6 KeV) are seen. The beam lines were of (Beam 1 from 12 to 36 keV) and Beam 2 from 0-12 KeV). The samples are as follows

|            |                          |
|------------|--------------------------|
| HD288      | Manually Powdered        |
| AKAW4210-6 | Manually Powdered        |
| TAW159     | Manually Powdered        |
| TAW33      | Manually Powdered        |
| NIAW1994   | Powdered by Tissue Lyzer |
| HD2888     | Powdered by Tissue Lyzer |
| AKAW4210-6 | Powdered by Tissue Lyzer |
| TAW159     | Powdered by Tissue Lyzer |
| TAW33      | Powdered by Tissue Lyzer |
| NIAW1994   | Whole Wheat Grain        |
| HD2888     | Whole Wheat Grain        |
| AKAW4210-6 | Whole Wheat Grain        |
| TAW159     | Whole Wheat Grain        |
| TAW33      | Whole Wheat Grain        |

**Table 2 – Gives the trace element concentrations in ppm**

| Al   | Si   | K    | Ca   | Fe  | Zn | Rb | Sr | Mn |
|------|------|------|------|-----|----|----|----|----|
| 1640 | 780  | 2244 | 796  | 102 | 59 | 4  | 11 | 56 |
| 1210 | 730  | 3202 | 1004 | 83  | 67 | 4  | 6  | 84 |
| 1500 | 670  | 3807 | 1222 | 89  | 47 | 6  | 17 | 77 |
| 1850 | 920  | 3382 | 977  | 61  | 37 | 4  | 17 | 52 |
| 1680 | 820  | 2278 | 852  | 74  | 30 | 2  | 11 | 77 |
| 1640 | 860  | 1425 | 1009 | 81  | 61 | 5  | 13 | 53 |
| 1770 | 830  | 2517 | 967  | 91  | 69 | 4  | 7  | 41 |
| 1570 | 860  | 2277 | 1239 | 86  | 42 | 7  | 9  | 72 |
| 1940 | 1030 | 2565 | 798  | 54  | 37 | 6  | 8  | 58 |
| 1550 | 880  | 1202 | 992  | 58  | 36 | 4  | 8  | 71 |
| ---  | 1210 | 8850 | 1347 | 120 | 76 | 7  | 4  | 86 |
| 1730 | 850  | 3550 | 1485 | 97  | 79 | 6  | 6  | 80 |
| 1600 | 1050 | 5750 | 2186 | 117 | 49 | 9  | 4  | 87 |
| 1250 | 950  | 3035 | 1440 | 78  | 40 | 8  | 6  | 73 |
| 1280 | 800  | 5290 | 1479 | 91  | 33 | 5  | 6  | 80 |

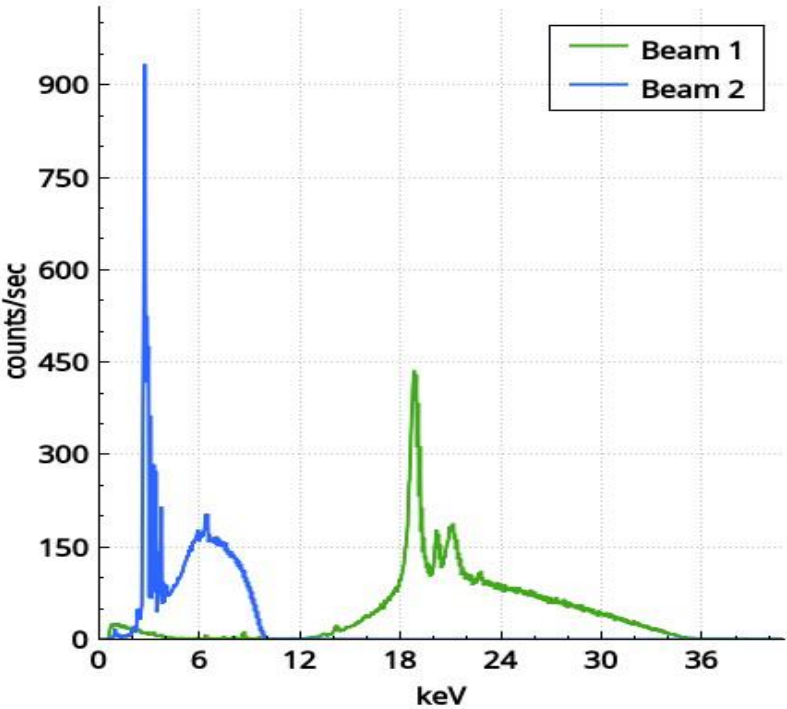


Figure 1: X-ray Spectrum of a Wheat Grain



Figure 2: An image of the HHXRF set up

### 3. Results and Discussion

The analysis shows that K is the major element followed by Al, Ca, Si and other minor elements like Fe, Zn, Mn, Rb and Mo. It is observed that Si is present significantly. Silicon the second most abundant element in the earth's crust, is not found free in nature, and occurs as oxides and silicates. It is present in the stroma of mammals probably giving them rigidity and strength. Silicon is found to be useful in the development of bone in two species of experimental animals which has been documented. Ca is essential in bone building. It is observed that toxic elements such as Pb, Hg are not present.

### 4. Conclusion

Al, Si, K, Ca, Fe and Zn are seen to be present significantly which are useful elements. There are no toxic elements which may harm the human consumption. The role of each of these elements needs to be investigated and the study is underway for further conclusions. Al, S and P which cannot be detected by many conventional instruments in XRF due to the detector window absorbing low energy X-rays could be detected by HHXRF. HHXRF has SDD (Silicon drift detector) which has a grapheme window and Al, P, S X-rays do not get absorbed unlike in the Si (Li) (Lithium drifted Silicon X-ray detector) which has Be window and absorbs

low energy X-rays below  $Z < 19$ . HHXRF can be a useful tool for detecting Al in samples.

## References

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