ELEMENTAL CHARACTERIZATION OF BREAD AND DURUM WHEAT BY INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS

C. Galinha[1,2], M.C. Freitas[2], A.M.G. Pacheco[1]

[1] CERENA/IST, Technical University of Lisbon, Av. Rovisco Pais, 1, 1049-001 Lisboa, Portugal
[2] *Instituto Tecnológico e Nuclear (ITN), URSN, E.N. 10, 2686-953 Sacavém, Portugal*

Introduction

Wheat is one of the most important agricultural food and feed crops worldwide, its production ranks second among all cereals with an annual production of almost 686 million tonnes and an area of 226 million hectare. It represents 27% of the total of all cereals world production (Faostat 2009 data). Humankind directly consumes more than 60% of this production. In addition to its basic caloric value, with its high protein content, is the most important source of plant protein in the human diet. Wheat supplies about 20% of the energy and about 25% of the protein requirements of the world population. Portugal is no exception to such pattern, accounting for the relative weight of cereals in Portuguese food consumption. In order to a possible nutrient supplementation, an extensive investigation of the levels of several elements in wheat and their agricultural soils was made, in the main wheat production areas of mainland Portugal. This paper is focused on two wheat species – bread and durum wheats; *Triticum aestivum* L. (Farak and Jordão cultivars) and *Triticum durum* Desf. (Don Duro and Simeto cultivars), respectively – from the 2009 campaign, collected at Trás-os-Montes, Alto and Baixo Alentejo (inland regions).

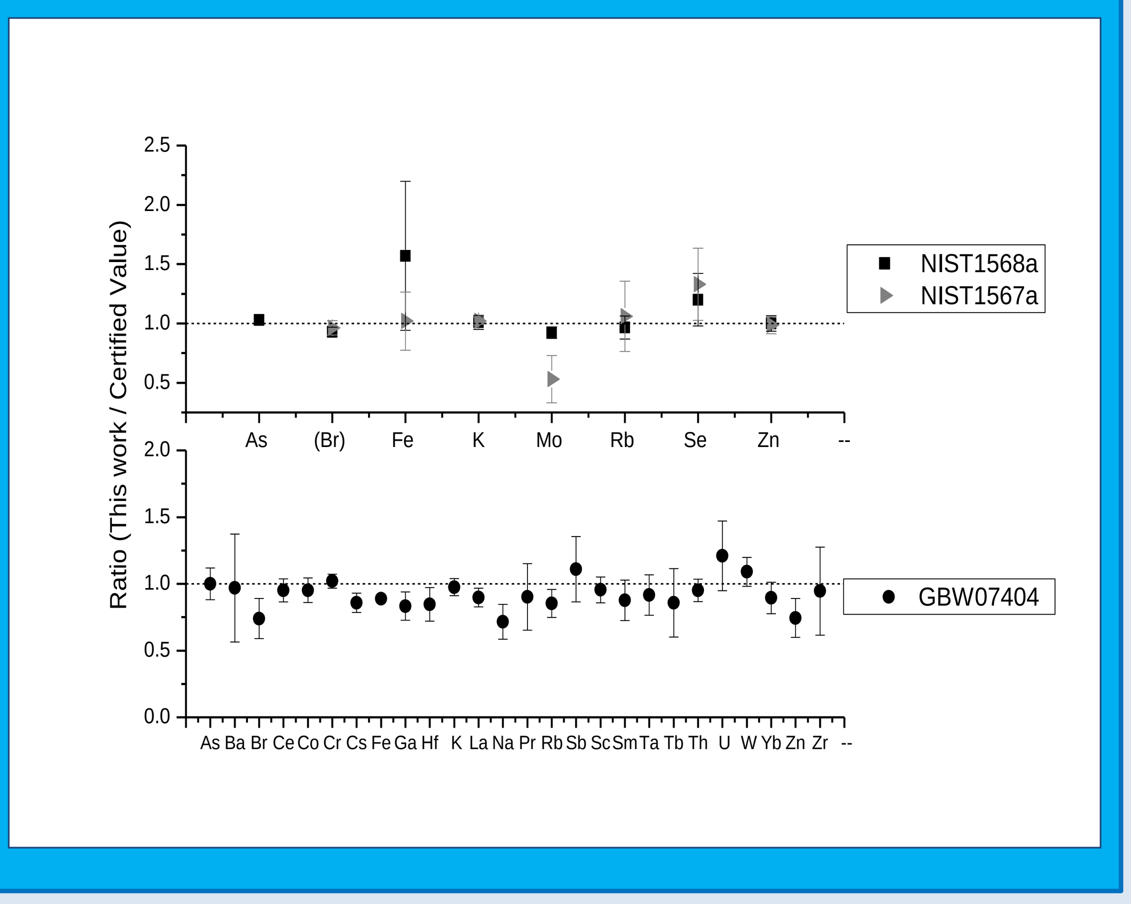
Methodology

Three different regions of Portugal were selected to sample cereal plants of *T. aestivum* L. and / or *T. durum* Desf.. Cultivars were sampled in July of 2009. Topsoil samples were collected from every sampling site at depths down to 15 cm. After sampling, the soils were allowed to dry at room temperature, mixed, homogenized, sieved and ground to a fine powder. Samples of about 150 mg each were then put into ultrapure polyethylene containers for further analysis. Cereal grains were collected from spike kernels, weighed, washed, frozen-stored, lyophilized, ground to a fine and then put into ultrapure polyethylene capsules (250-300 mg each). All samples were irradiated at the Portuguese Research Reactor (RPI-ITN; Sacavém) for 1h (soil samples) and 5h (grain samples), at a thermal neutron flux density of 2.25×10^{12} n cm^{-2} s^{-1}, together with disks of an Al-0.1% Au alloy as comparators. Gamma spectra were acquired with a liquid N_2-cooled, high-purity Ge detector. Samples were measured after 2–3 days and 3–4weeks of decay time and comparators were measured after one week. Elemental concentrations were determined through k_0-standardized, instrumental neutron activation analysis (k_0-INAA).

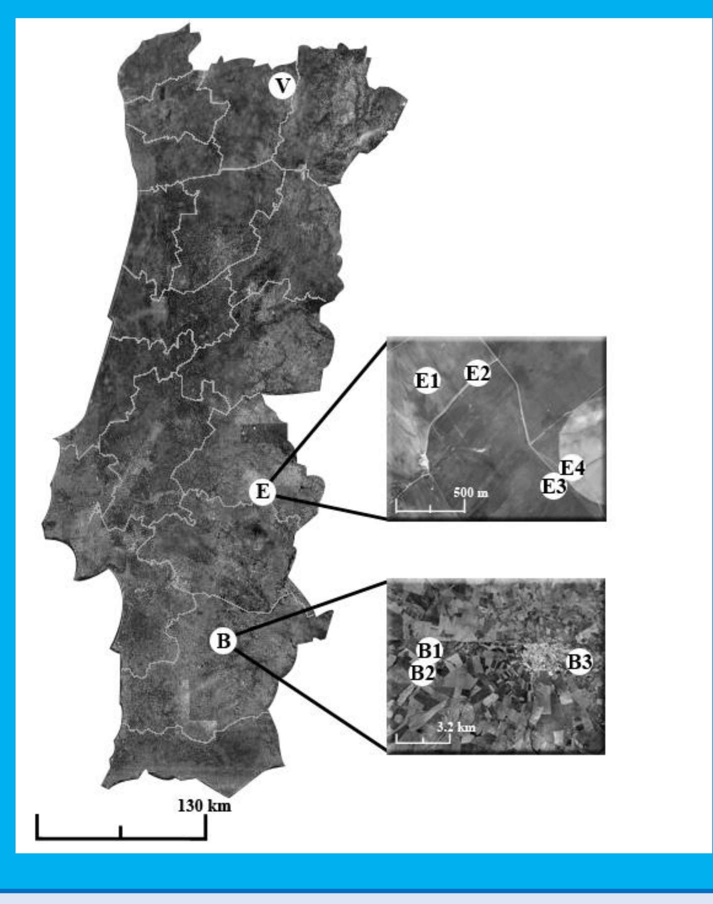
Quality of Results

Ratio
This Work / Certified Value
(67% Confidence)

Note: For SRM's NIST 1567/8a the values of bromine are only indicative

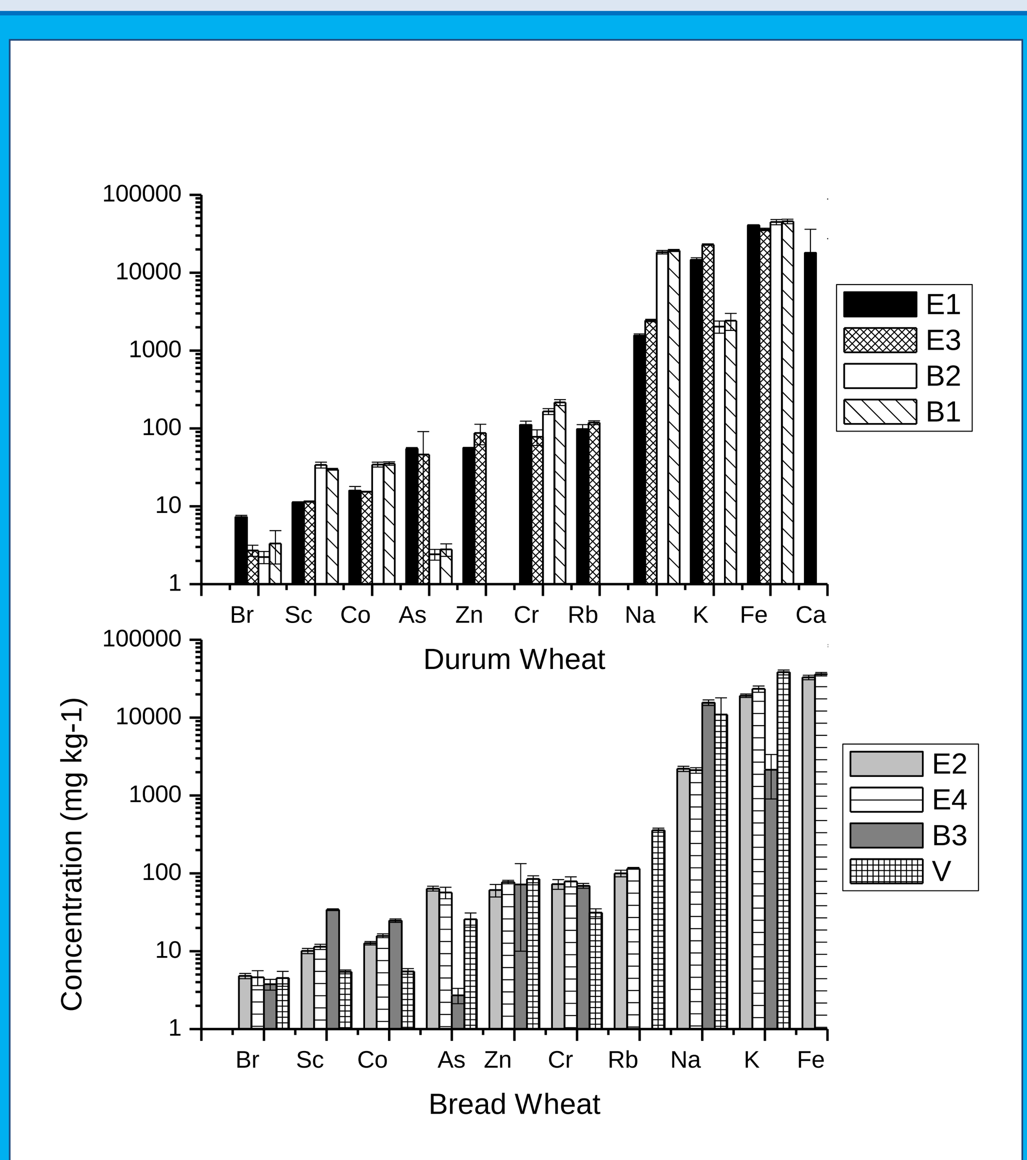


Sampling Site Characterization

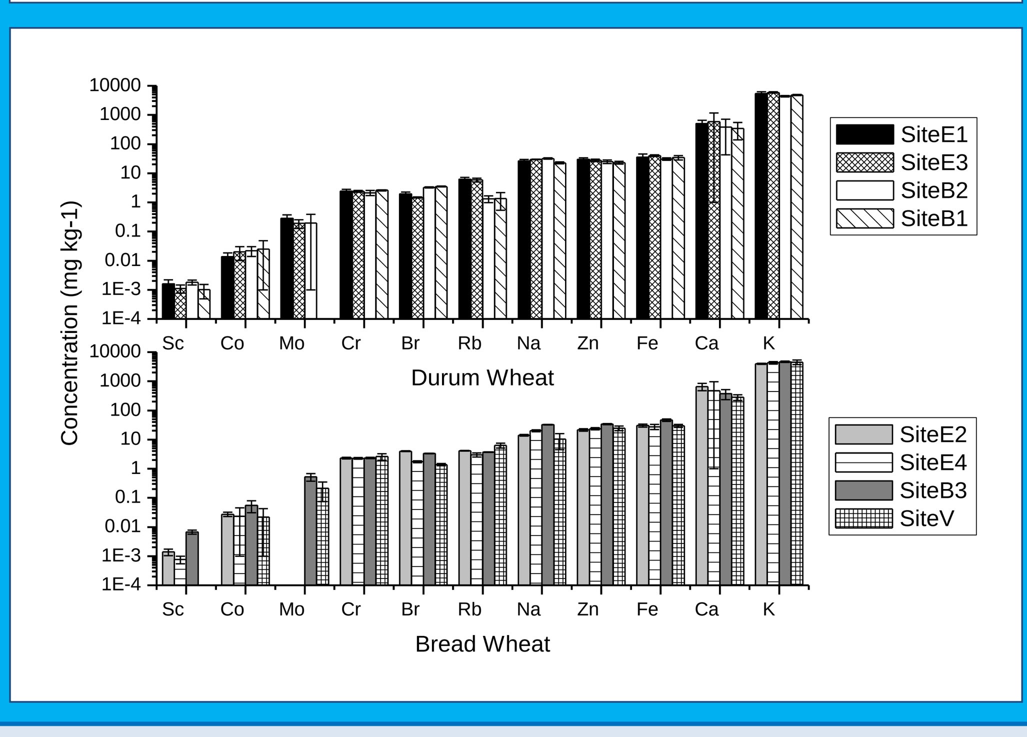


Results

Elemental concentrations (mg kg^{-1}) determined in samples of cultivation soils from fields of bread and durum wheat cultivars.



Elemental concentrations (mg kg^{-1} – dry weight) determined in samples of grains of bread and durum wheat.



Discussion

- The elemental concentrations in soils increased in the order of Br < Sc < Co < As < Zn < Cr < Rb < Na < K < Fe < Ca and the wheat grains in the order of Sc < Co < Mo < Cr < Br < Rb < Na < Zn < Fe < Ca < K
- All the concentrations obtained for cobalt in soils were below the Canadian soil quality guidelines – 40 mg kg^{-1} – with the highest value for site B1 with a concentration of 35 ± 2 mg kg^{-1}
- Concentrations of zinc in soils ranges from 55 to 90 mg kg^{-1}, that is in concordance with the ones found in the bibliography available and far below the maximum tolerable limit of 300 mg kg^{-1}
- Chromium results are above Canadian soil quality guideline as well – 64 mg kg^{-1} – with exception of site V
- Sodium concentrations in soils are significantly lower in sites E while distribution of potassium shows exactly the opposite, with sites E having higher values than sites B, meaning that probably the fertilizers used in agricultural fields from sites E are enriched in potassium and the ones used in sites B enriched in sodium
- Arsenic content in soil from sites E are slightly above the permissible limit for agricultural soils, however wheat grains do not show significant levels of this element
- Although arsenic content of soils from sites E were higher than other sites, this trend does not occur in the grains, which means that wheat does not has a tendency to accumulate arsenic in the grain
- Contents of cobalt in wheat grain samples were near to the normal content of this element in wheat (0.05 mg kg^{-1}) and it is very far from the reported toxic intake of 500 mg day^{-1}
- Toxic intake of chromium is 200mg, so there is a very small contribution of chromium (less than 0.1%) to dietary intake of an adult by eating bread made of wheat

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