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Levels of some Anions in Selected Grains Grown in Jigawa State, Nigeria

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ABSTRACT

The levels of some anions (NO_2^-, NO_3^-, SO_4^{2-} and PO_4^{3-}) in selected grains (rice, maize, millet and corn) grown in some parts of Jigawa state, Nigeria, have been quantitatively determined by spectrophotometric technique. Samples were randomly collected from the sampling locations (Kiyawa, Jahun, Birnin Kudu, Dutse and Gwaram) local government areas of Jigawa state and analysed for their anion contents. Results obtained showed the range of mean concentrations of the anions in the food grains as; nitrite (3.20±0.87 to 17.51±1.06mg/kg), Nitrate (2.59±0.17 to 12.99±1.17 mg/kg), sulphate (8.04.±1.90 to 27.58±0.68mg/kg) and phosphate (8.37±1.77 to 44.30±1.79mg/kg). Nitrite, nitrate and sulphate levels were found to be below the permissible limit set by FAO/WHO. Phosphate was slightly higher than the permissible limit in just one sample (Birnin Kudu corn).Generally, it can be concluded that the grains analysed are safe for human consumption.

Keywords: Anions, Grains, Permissible Limit, Random Sampling, Spectrophotometry

INTRODUCTION

The primary source of food for the ever-increasing population of the world is agriculture. Grains are by far the most important sources of total food intake in the world as measured in calories (Hord *et al.,* 2009). It is also expected that grains will continue to supply more than 60 percent of the food consumed in the foreseeable future. The projection reflects the prospect in the majority of developing countries like Nigeria where consumption of grains such as rice, maize, beans, wheat etc. is a priority. Food and vegetable crops production and its attendant security is an essential feature of a nation's economic stability. It needs access to fertile land, water and in some instances and all other inputs so as to boast the production especially in poor and developing countries of the world (Akan *et al.,* 2009).

Mineral elements are considered to be important in our diet and can enter the food crops or vegetables from soil and water via mineralization by crops, food processing or environmental pollution (Akan *et al.,* 2009). Though efforts are being consolidated by the government towards improving and increasing food and vegetable crops production, the problem of industrial effluents into water bodies is undermining these efforts, especially in areas where tannery and textile effluents are discharged into drain which is used for the irrigation of crops during the dry season farming (Akan *et al.,* 2009). Anthropogenic activities aimed at improving the quality of life on earth have adversely affected the concentration of chemical substances in soil higher than their natural levels; thereby making them toxic to plants grown on them and subsequently creating serious problems along the food chain (Ebong and Etuk, 2017).

Anions are atoms or radicals (groups of atoms) that have gained electrons. Since they now have more electrons than protons, anions have a negative charge. For example, chloride ions (Cl^-), Bromide (Br^-), Iodide (I^-), sulphate (SO_4^{2-}), phosphate (PO_4^{2-}), Nitrate (NO_3^-), Nitrite (NO_2^-) etc. (Hassan *et al.,* 2009). They exist generally in the form of metallic salt and may be supplied to the organic form as potassium chloride (KCl), zinc sulphate ($ZnSO_4$), potassium nitrate (KNO_3) and polyphosphate or in the formulated of mixed fertilizer (AFRR, 2000). The major sources of anions are the soil which under favourable condition make them available to plant and then human through diets. They need active transport across the plasmalemma of the plant root cells for uptake (Rubio *et al.*, 2005).

The aim of this research is to determine the levels of anions namely, nitrite (NO_2^-), nitrate (NO_3^-), sulphate (SO_4^{2-}) and phosphate (PO_4^{3-}) in grains from selected parts of Jigawa State, Nigeria. The results obtained could be used to justify the safety of consuming such food crops grown in the state as no much current researches are reported to cover the studied areas involved in this work.

MATERIALS AND METHODS

Reagents of analytical grade purity and deionized water were used throughout this work. All glasswares were washed with liquid detergent, rinsed with distilled water and soaked in 10% (v/v) HNO_3 overnight prior to drying in an oven at 105^oC. Weighing was done using Mettler analytical weighing balance model XP205.

Sample Collection

Four (4) different grain samples (viz. maize, rice, millet and corn) were randomly collected in separate containers from three locations in each Local Government Headquarter (Gwaram, Birnin Kudu, Kiyawa, Dutse and Jahun) of Jigawa state. Prior to analysis, all samples were washed with deionized water to remove any adhered materials and soil particles from them.

Sample Pre-Treatment

The grain samples were washed with de ionized water and dried at 105^oC for 2hr in an oven. The dried samples were ground using pestle and mortar until a powder was produced. The powdered samples were then sieved through a 0.5µm mesh and stored in an air tight plastic container. Prior to acid digestion, the samples were converted into ashes at 500^oC for 3 hr in a furnace.

Digestion of Samples

One-gram (1.0g) portion of each sample was measured separately into a Pyrex beaker, 5cm^3 of HCl was then added. The mixture was digested on a hot plate until a clear solution was obtained. The content of the beaker was then allowed to cool, filtered using filter paper and diluted with distilled water in 50cm^3 volumetric flasks. This was done in triplicate, blank solution was also made. The solutions prepared were analysed for sulphate (SO_4^{2-}), phosphate (PO_4^{3-}), nitrite (NO_2^-) and nitrate (NO_3^-), using U.N.S spectrophotometer (2010). A calibration curve of absorbance against concentration of each anion under investigation was plotted from which the concentrations of the anions were determined (Radojevic and Bashkin, 1999).

RESULTS AND DISCUSSION

Four (4) different anions were determined in four (4) grain samples grown in Jigawa state. The levels of anions found in the samples are presented in Figures 1 – 4

The nitrite content (17.51 mg/kg) was found to be highest in corn sample from Jahun (Figure 4) followed by 10.33 mg/kg observed in Jahun millet (Figure 3), Jahun rice, 7.80 mg/kg (Figure 1), Jahun maize, 7.20 mg/kg (Figure 2) and the lowest concentration, 3.20 mg/kg was observed in Dutse rice (Figure 1). From this trend, it can be ascertained that Jahun soil might be rich in nitrite ions possibly as a result of application of agrochemicals (e.g. fertilizer) or other means, which get absorbed into the grains grown on the soil compared to the other sampling areas. In a similar investigation conducted in Kaduna state, Abdulrazak *et al.* (2004) reported a range of nitrite concentration as 0.030 mg/kg – 0.087 mg/kg in different grains analysed which is lower compared to the present work and this could be due to geographical influence and possibly low level of nitrite ions in the soil at the location. The nitrite content in all the grains analysed was found to be within the permissible limit of nitrite set by FAO/WHO (2000).

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Figure1: Concentration of anions (mg/kg) in Rice

The nitrate concentration ranged from 2.59 mg/kg to 12.99 mg/kg. Similar trend was observed as in the case of nitrite ions, with the exception of maize, all samples from Jahun were observed to have the highest nitrate concentrations. Birnin Kudu maize recorded the lowest concentration of nitrate, 2.59 mg/kg (Figure 2). The similarity in trend for both nitrite and nitrate ions in grains from Jahun is not surprising and this could be due to the oxidation of nitrite to nitrate in the soil by Nitrobacter bacteria. Abdulrazak *et al.* (2014) indicated a range of 3.00 mg/kg to 21.3 mg/kg for nitrate ions in the grains analysed which is higher with respect to what was obtained in the present research. This could possibly be attributed to high conversion of nitrite to nitrate ions presumably due to abundant Nitrobacter in the soil where the grains were grown. In both cases, the nitrate content in all the grains analysed was found to be within the permissible limit of nitrate in grains which is 100mg/kg (FAO/WHO, 2000).

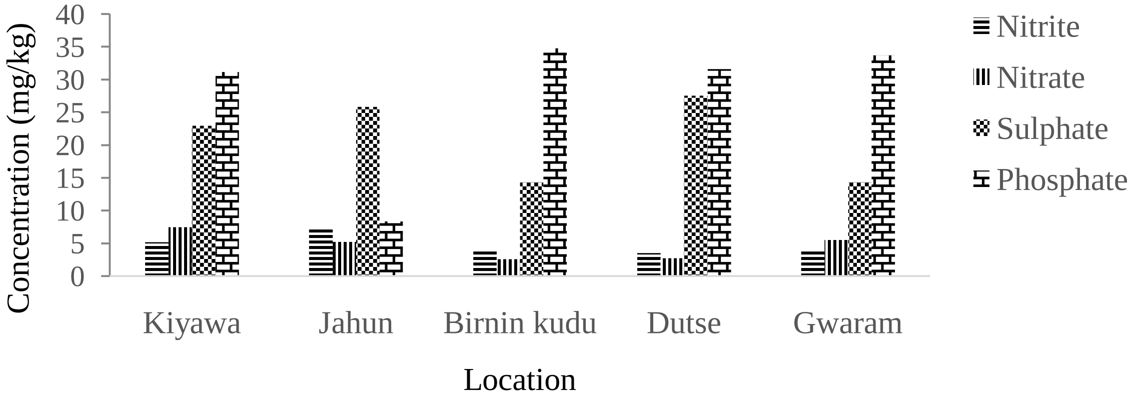

Figure 2: Concentration of anions (mg/kg) in Maize

Sulphate content of 27.58 mg/kg in corn sample from Birnin Kudu was found to be highest (Figure 4). This is followed by 25.86 mg/kg observed in Jahun maize (Figure 2), Birnin Kudu rice, 24.71 mg/kg (Figure 1), Jahun millet, 20.68 mg/kg (Figure 3) and the lowest concentration, 8.04 mg/kg was observed in Kiyawa rice (Figure 1). From the results, it can be deduced that Birnin Kudu and Jahun grain samples contain more sulphate ions than grains from other sampling locations. The results obtained in this work were lower than those reported for sulphate in grains (36.25 mg/kg to 4.05 mg/kg) by Edeogu *et al.* (2006). Similarly, the sulphate levels in all the grains analysed were found to be below the permissible limit (250 mg/kg) set by FAO/WHO (2000).

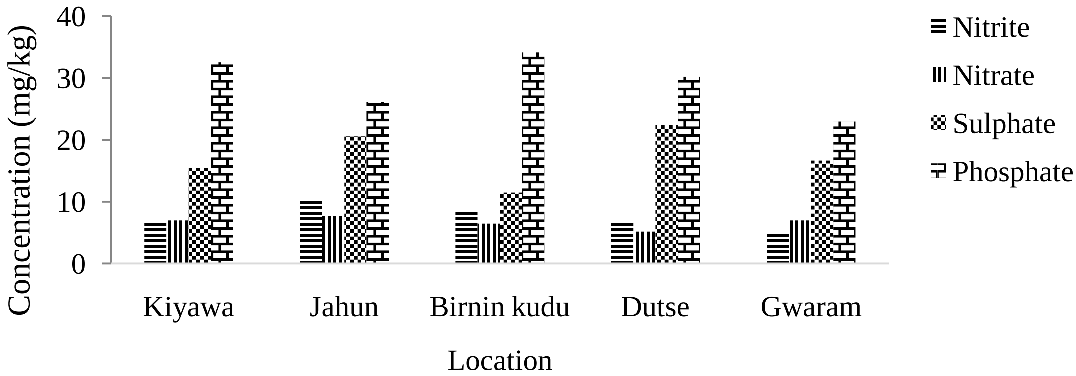

Figure 3: Concentration of anions (mg/kg) in Millet

For all the grains (rice, maize, millet and corn), Birnin Kudu samples had the highest concentrations of phosphate. Birnin Kudu corn with concentration of 44.30 mg/kg (Figure 4) has the highest phosphate level. For maize grain, Birnin Kudu sample also has the highest phosphate concentration, 34.78 mg/kg (Figure 2), Similarly for millet, Birnin Kudu sample had the highest phosphate level, 34.18 mg/kg (Figure 3), and finally, Birnin Kudu rice, 20.10 mg/kg (Figure 1). This is an indication that Birnin Kudu soil on which the grains were grown has sufficient phosphate ions compared to other locations. The lowest phosphate concentration however was observed in Jahun maize, 8.37 mg/kg (Figure 2).Apart from Birnin Kudu corn sample which is slightly above the permissible limit of 40 mg/kg set by FAO/WHO (2000), all other grains were found to be below the limit. The results obtained were generally far lower than the ones reported by Ogugbuaja *et al.* (2009) as 2750mg/g to 771.40mg/g. The large difference in the phosphate levels could be due to mineralization of organic matter or influences of excessive application of some agro-chemicals such as fertilzers, pesticides etc. during farming(Prasad, 2019).

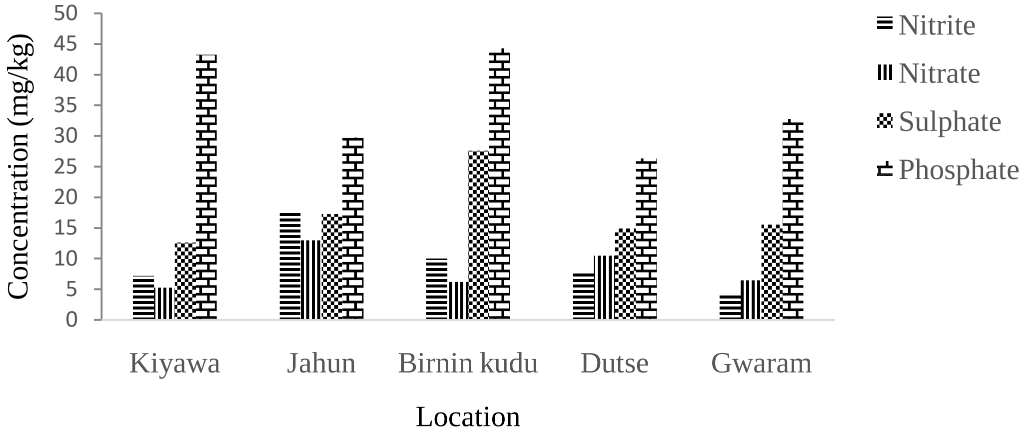

Figure4: Concentration of anions (mg/kg) in Corn

CONCLUSION

This study revealed that the concentrations of the target anions in the grain samples analysed were within the tolerable human intake level. Nitrite, nitrate and sulphate levels were found to be below the permissible limit set by FAO/WHO (2000). However, phosphate was found to be slightly higher than the permissible limit in Birnin Kudu corn sample. On the overall, it can established be that the grains analysed were so far safe for human consumption.

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