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Evaluation of some elemental variation in raw Egg Yolk and Egg White of Domestic Chicken, Guinea Fowl and Duck Eggs

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ABSTRACT

A preliminary study was conducted to investigate the contents in yolk and albumen of trace minerals Al, Br, Ca, Cl, K, Mg, Na in eggs from Domestic chicken, Guinea Fowls and Ducks. These courtyard birds were fed on cereals, legumes, grass and swill. Trace element contents in yolks were generally higher than those in albumen except for Br and Cl. The highest content of Ca in yolks was in Guinea fowl. Cl concentration was highest in chicken yolk. The concentration of K was highest in Guinea fowl yolk, and Na contents were highest in duck yolk. Mg was seen only in the chicken eggs with the higher concentration in the yolk than in albumen. The results provide baseline measurements of trace mineral contents of eggs and suggest measurable differences amongst the eggs from chicken ducks and guinea fowls; these differences are discussed in details.

Keywords: Chicken, Duck, Guinea Fowl, Trace elements, INAA.

INTRODUCTION

A balanced diet is important for proper growth and preservation of the human body. Beside the main nutritional values which include Carbohydrates, protein, vitamins, etc, the body also needs an amount of essential elements for various metabolic processes. For a number of reasons, eggs have constituted an important part of human diets for centuries because of its high quality protein which makes them nutritious [1]. The many benefits of egg are shared worldwide. As in several source of food, eggs can contain inorganic elements which may be essential or detrimental to human health. Thus, eggs may be contaminated directly or indirectly through the food consumed by the birds and due to environmental contamination [2].

In order to assess the competence of human diets, it is necessary to monitor food of frequent consumptions and measure trace elements contents to establish baseline levels of essential, potentially toxic and toxic elements. Therefore the purpose of this study was to determine variations in some trace elements in domestic Chicken, duck and guinea fowl eggs by Instrumental Neutron Activation Analysis (INAA).

MATERIALS AND METHODS

Selection of a representative sample and the uncertainties associated in sampling are beyond the control of analysts due to the inhomogeneous nature of foodstuff. For the purpose of minimizing such sampling uncertainties in this work, six (6) samples of domestic fowls' eggs, guinea fowl eggs and Duck eggs were randomly collected from different localities in the Accra Metropolis, Ghana. Samples were thoroughly washed with deionized water in the laboratory at the National Reactors Research Centre. The eggs white and egg yolk were separated for each egg and freeze-dried. The samples were then homogenized and pack in sealed polyethylene bags. Triplicates of each sample weighing between 250 – 300 mg was weighed directly onto pre-cleaned polyethylene films and heat sealed and then packed into polyethylene vials and heat-sealed ready for irradiation. For validation of analytical method, NIST Standard reference material SRM 8435 (Whole milk powder) was selected as the standard. A weighed mass of the standard was also packed and sealed as the sample. After appropriate irradiation and cooling, both sample and standard are counted for the gamma spectra. Table 1 shows the various groups for irradiation and gamma energies. The first group containing Al, Ca, Cl, Mg were irradiated for 2 minutes and counted for 10 minutes. For the following group, samples were irradiated for 1 hour and cooled for 24 hours before counting for 10 minutes. The measurement for the gamma ray spectra was done using a spectroscopy system comprising of a high purity germanium detector coupled with an ORTEC multi channel analyzer.

RESULTS AND DISCUSSION

Concentrations of seven (7) elements in domestic chicken eggs, guinea fowl eggs, and duck eggs were determined using INAA technique by varying irradiation, cooling and counting times. The concentrations of Al, Br, Ca, Cl, K, Mg, and Na are presented in table 2. Results of analysis of a standard reference material for validation are also presented in table 3. All elements considered in this study had higher concentrations in the yolk than in the egg-white except for Br and Cl whose concentrations were higher in the egg- white than in the yolk for all the species considered. Aluminum concentration ranged from 5.13µg/g to 11.43µg/g; the highest concentration was recorded in the yolk of duck egg whiles the least Al content was measured in the egg white of guinea fowl. Al concentration in food is of concern due to its linkage with Alzheimer's disease. In 'dialysis dementia', corresponding cortical aluminum concentrations are reported to be 20-30tig/g in adults[3].

Studies have shown that Ca is an essential element for healthy teeth, bones and blood [4],[5]. Concentrations of Ca measured in this study are also presented in table 2.

Figure 1 shows variations of Aluminium concentrations in the samples. Bromine on the other hand demonstrated a high concentration in duck egg white. Chlorine, potassium, and sodium act as electrolytes for ionic and osmotic balance, to strengthen cells and the endoskeleton [6]. Sodium is an essential nutrient, the cation mainly responsible for regulating extracellular fluid volume and plasma volume [7]. Chlorine is also an essential trace element in the human body. It is a major anion of the extracellular fluid occurring in plasma, lymph, connective tissues, cartilage and bone. Potassium is equally an essential element is potassium [8], [9]. A graph showing the variations in concentration of these electrolytes is seen in Fig. 4. Chlorine showed the highest concentration among the 3 elements. It exhibited higher concentrations in the egg whites of the various species. Sodium and chlorine presented relatively similar concentrations in all the species.

Table 1 Nuclear data of nuclides determined in this work

Element	Target Isotope	Product Nuclide	Half-life	Gamma-ray energy keV
Al	^{27}Al	^{28}Al	2.24 min	1778.9
Ca	^{48}Ca	^{49}Ca	8.72 min	3084.54
Cl	^{37}Cl	^{38}Cl	37.24 min	1642.7, 2167.7
Mg	^{26}Mg	^{27}Mg	9.46 min	1014.43
Br	^{81}Br	^{82}Br	35.3h	554.35, 776.52
K	^{41}K	^{42}K	12.36 h	1524.58
Na	^{23}Na	^{24}Na	14.96 h	1368.6, 2754

Table 2: Concentrations of elements in samples in µg/g or otherwise stated

	Duck		**Guinea Fowl**		**Chicken**	
Element	White	Yolk	White	Yolk	White	Yolk
Al	7.84 ± 0.31	11. 43 ± 0.53	5.13 ± 0.29	11.36 ± 0.34	5.65 ± 0.26	8.01 ± 0.01
Br	15.05 ± 1.57	11.14 ± 1.10	13.86 ± 1.31	8.96 ± 0.86	ND	ND
Ca (%)	0.27 ± 0.03	0.55 ± 0.02	0.30 ± 0.03	0.57 ± 0.03	0.28 ± 0.02	0.37 ± 0.03
Cl (%)	0.97 ± 0.01	0.69 ± 0.04	0.83 ± 0.01	0.57 ± 0.03	1.13 ± 0.003	0.98 ± 0.01
K (%)	0.24 ± 0.02	0.28 ± 0.02	0.22 ± 0.02	0.34 ± 0.02	0.21 ± 0.02	0.30 ± 0.02
Mg	ND	ND	ND	ND	54.45 ± 4.23	42.33 ± 4.12
Na (%)	0.34 ± 0.001	0.32 ± 0.001	0.31 ± 0.001	0.26 ± 0.001	0.31 ± 0.001	0.27 ± 0.002

ND. Not Detected

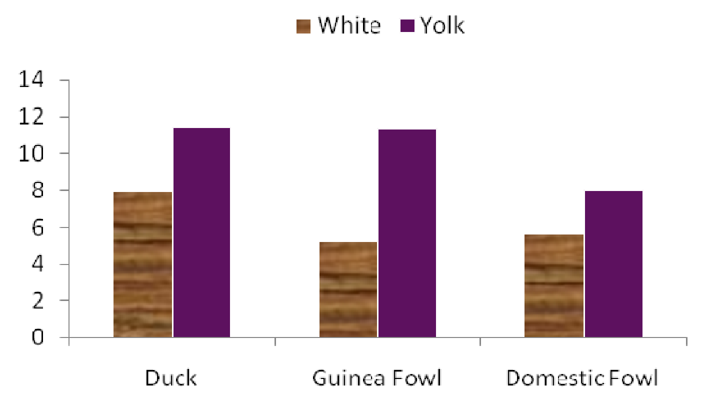

Fig. 1: Concentration of Al (µg/g)

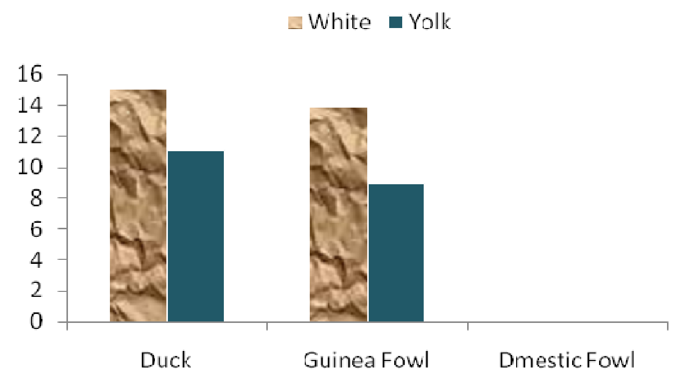

Fig. 2: Concentration of Br (μg/g)

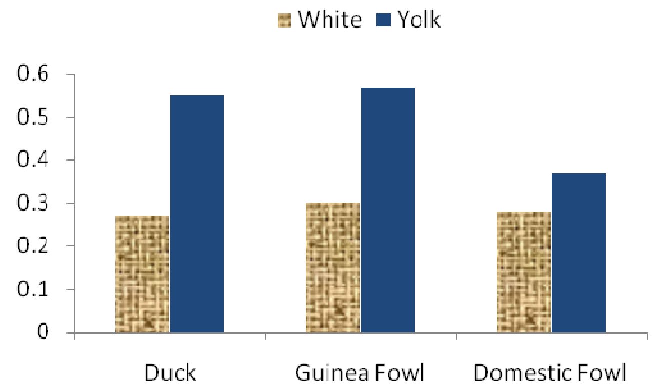

Fig. 3: Concentration of Ca (%)

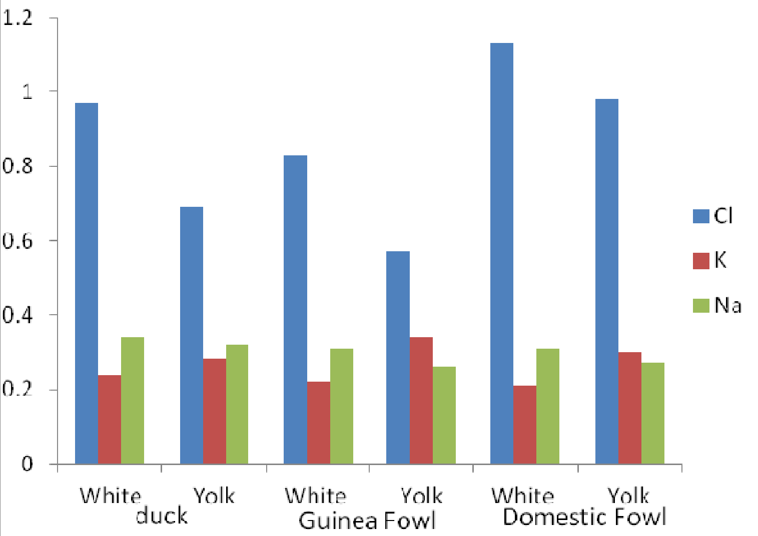

Fig 4. Concentrations of Cl, K, and Na in egg white and yolk of duck, guinea fowl and domestic fowl samples

Table 2 Concentrations of elements in SRM 8435 Whole Milk Powder

Element	This work	Reported
Br (μg/g)	19.5 ± 0.56	20 ± 10
Ca (%)	0.91 ± 0.05	0.922 ± 0.049
Cl (%)	0.86 ± 0.07	0.842 ± 0.044
K (%)	1.33 ± 0.10	1.363 ± 0.047
Mg (μg/g)	811 ± 80	814 ± 76
Na (%)	0.34 ± 0.03	0.356 ± 0.040

CONCLUSION

In this study, duck, domestic fowl and guinea fowl eggs were analyzed using Instrumental neutron activation analysis to determine some elemental contents in the egg whites and egg yolk from the afore mentioned species . The distribution of the elements indicates that there is a variation in their contents in the various species of eggs, for both the yolk and the egg white. Concentrations of elements, apart from Br and Cl, were higher in the yolk than in the egg -white. The concentrations were however within tolerable limits.

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