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Evaluation of Some Anti-Nutritional Factors and Elements in Bread Samples from the Greater Accra Metropolis in Ghana

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ABSTRACT [ENGLISH/ANGLAIS]

Twenty One (21) different brands of bread samples were collected from different markets/ bakeries in the Greater Accra region of Ghana. The bread were formulated with prepared from white flour and whole meal flour. Presence of Aanti nutritional factors and trace elements were determinedwas assessed. Seven (7) trace elements were measured using Instrumental Neutron Activation Analysis (INAA). The over alloverall average of for each of these the investigated elements in the bread samples investigated are: as follows Ca 0.20% , Cl 0.43 %, Al 0.47 mg/kg, Cu 0.71 mg/kg , Mg 333.63 mg/kg , Mn 6.19 mg/kg , Na 0.20 % and K 0.19 %. Neither As nor Cd were detected in any of the samples studied in this work. The results for the anti nutritional factors show that though the concentrations were present in the samples, their concentrations fell within acceptable limits did not exceed lethal doses. Oxalates were present in all samples taken with the greatest concentration at 21.91 mg/100g whereas hydrocyanide was present in only 15 samples with the highest concentration of 18.58 mg/j100g. The concentrations of the anti Nutritional factors in the samples were quite different from each other.

Keywords: Ghana, anti-nutritional factors, bread, INAA, oxalates, hydrocynic acidghana

RÉSUMÉ [FRANÇAIS/FRENCH]

Vingt et un (21) de différentes marques d'échantillons de pain ont été recueillies à partir des différents marchés / boulangeries dans la région du Grand Accra au Ghana. Le pain ont été formulés avec préparés à partir de farine blanche et farine complète. Présence de facteurs nutritionnels et oligo-éléments Aanti étaient determinedwas évalué. Sept (7) en oligo-éléments ont été mesurés en utilisant l'analyse instrumentale par activation neutronique (INAA). La moyenne sur des alloverall pour chacun de ces éléments l'enquête dans les échantillons étudiés sont le pain: comme suit Ca 0,20%, Cl 0,43%, 0,47 Al mg / kg, Cu 0,71 mg / kg, Mg 333,63 mg / kg, 6,19 mg Mn / kg, 0,20% de Na et K 0,19%. Ni Comme ni Cd ont été détectés dans aucun des échantillons étudiés dans ce travail. Les résultats pour les facteurs anti nutritionnels montrent que si les concentrations étaient présents dans les échantillons, leur concentration a chuté dans des limites acceptables ne pas dépasser des doses létales. Les oxalates sont présents dans tous les échantillons prélevés avec la plus grande concentration au 21.91 mg/100g alors hydrocyanide était présent dans seulement 15 échantillons avec la plus grande concentration de 18,58 mg/j100g. Les concentrations des facteurs anti nutritionnels dans les échantillons étaient très différents les uns des autres.

Mots-clés: Le Ghana, Anti-facteurs nutritionnels, du pain, INAA, les oxalates, hydrocynic acidghana

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INTRODUCTION

Ghana's population from the preliminary results of the 2010 census is 24,223,431 [1]. Accra, the capital city has a population of 3,909,764 as according to 2010 census by the Ghana Statistical service [1] and an area of 894 square kilometers [2]. In recent times, it is observed that bread has become a major food item which forms part of breakfast in most homes mostly in the diet of children. There is therefore the need to ascertain the elemental contents and anti nutritional factors in bread since it is of great importance particularly in children.

Anti-nutrients are chemical substances in food that do not offer nourishment to the body. e.g. oxalates, and hydrocyanic acids. The effects of an anti-nutrients in the body depend on the type and the concentration in which it is present in the food material(s) [3-5]. Oxalate is

produced and accumulated in many crops and pasture weeds [6]. The nutritional importance of trace elements has been well established and their roles in human health and diseases have been well documented [7-9]. It is then rational to determine the level of trace elements in bread for nutritional and regulatory purposes. This study hence determine seven (7) essential, 1 non essential trace element in twenty bread samples obtained from markets in the Greater Accra metropolis using Instrumental neutron activation analysis (INAA) and 2 anti nutritional factors..

MATERIALS AND METHODS

Sampling and Sample Preparation

Twenty different branded samples were randomly purchased from the local markets in the Greater Accra metropolis of Ghana. The samples were then transported to the laboratory. In the laboratory, the samples were sliced into pieces using a stainless steel knife on a plastic chopping board. The sliced samples were freeze dried and thoroughly homogenized after milling.

Elemental Analysis

Aliquots (about 250.00 mg) of the homogenized samples were weighed onto clean polyethylene films wrapped and heat sealed. 5 replicates of each sample were prepared. Also, three replicates of SRM 1567, wheat flour from National Institute of standards and Technology, USA. The reference material was used to check the accuracy of the analytical method used. For medium lived elements, the reference material was "sandwiched" between two samples. This was to ensure that samples and standard were subjected to the same conditions. Samples were then irradiated for 3600 seconds delayed for 24 hours and counted for 600 seconds. For short lived elements, samples and standards were irradiated for 300 seconds and counted for 600 seconds. The irradiation and gamma spectra analysis were done at the Ghana Research Reactor – 1 centre. The peak area of the gamma spectrum was evaluated using a high purity germanium detector and gamma spectroscopy accumulation software, ORTEC MAESTRO – 32.

Hydrocyanic Acid Determination -Alkaline Titration Method

Small quantity of the bread samples was grinded and rejected. Then sufficient quantity of the remaining sample was grinded to pass through 1.0 mm sieve. 20 gm of the ground and sieved samples were weighed and transferred into 1 litre distillation flask and 200 ml distilled water added and left to stand for two hours. It was then steam distilled and between 150- 160 ml of the distillate collected in 20 ml of 6.5 M NaOH solution. This was then diluted to 250 ml. 100 ml aliquot was taken and 8 ml of 6 M NH_3 was added followed by 2 ml of potassium iodide solution and titrated with 0.02 M $AgNO_3$ until permanent turbidity appears. Black background was used to enable easy detection of the end point of the titration.

Oxalate Determination: Permanganate Titration Method

The Permanganate Solution was first standardised with Sodium Oxalate by weighing out accurately 0.20g of pure sodium oxalate into a 400 ml beaker. 250 ml of 1.0M sulfuric acid was then added, stirred and warmed on a heating mantle until the oxalate is dissolved at around 70-80 ^oC. The acidified oxalate solution was then titrated with the permanganate, stirring constantly while above 70 ^oC until a permanent pink colour was developed. 2.0g of ground and sieved sample was weighed into a 400 ml beaker and 250 ml of 1.0M sulfuric acid added. Titration with the standardized permanganate solution was then carried out as above.

RESULTS AND DISCUSSION

The results of the anti nutritional contents of bread from the Accra metropolis is shown in table 1. The anti nutritional factors considered in this work included Oxalates and Hydrocyanic acids. The anti nutritional roles of these toxicants have been discussed [4, 5] and they include inhibitory roles such as inhibition of the activity of vitamin K dependent carboxylase of the liver etc. The hydrocyanic acid content in the analyzed bread samples were in the range of 1.19 - 18.58 mg/100 g. The results also show low concentrations of hydrocyanic acids and were present in 15 of the samples studied. This is expected because the release of hydrocyanic acid from the precursor glycoside is enzymatic. Heat treatment therefore affects the activity of this enzyme. [10]

HCN is a very volatile compound which can easily be eliminated by heat. It can inhibit cellular oxidation by combining with catalytic ion of cytochrome oxidase leading to elimination of the active unit concerned with transfer of electrons to molecular oxygen. The lethal dose of HCN reported by Eneobong [11] was 35 mg per kg body weight. On the other hand, Burn [12] reports that the

body has a way of detoxifying small amounts of HCN in food by converting it to thiocynide, which is excreted in the urine. This research has shown that the HCN content in bread is well below the lethal dose.

The levels of oxalates ranged from 6.66 – 21.91 mg/100 g. These are slightly higher than what was observed in HCN. Oxalates can form complexes with most essential trace elements therefore making them unavailable for enzymatic activities and other metabolic processes. Consumption of large doses of oxalic acids causes corrosive gastroenteritis, shock, convulsive symptoms, low plasma calcium, high plasma oxalates and renal damage. [11] The lethal dose of oxalates has been reported to be 3 – 5 g for man. [13]

The results for the elements in the bread samples and the standard reference materials are presented in tables 2 and 3. There was no significant variation of Sodium in most of the samples analyzed. It ranged from 0.21 % to 0.42% with a mean of 0.20 %. Though from different bakeries, similarity may be attributed to similar ingredients used in the preparation of bread by the bakeries. Those with variations may be due to the type of bread that requires addition of NaCl. Sodium is a major physiological element and primary extra – cellular cations in humans. Na, together with Cl, and K act as electrolytes to maintain normal fluid balance inside and outside cells and also a balance of acids and bases in the body. Cl and K were also present in the samples at major concentrations. The highest concentration of Cl was seen in BE 1 at a concentration of 0.63 and MA 1 contained the lowest concentration of 0.31. All concentrations are in percentage. Copper was detected in 3 of the 20 samples analysed with a mean concentration of 0.71 mg/kg. Ca which is also an essential element was present at significant concentration levels. Ca concentrations ranged from 0.09 – 0.37 %. The function of calcium in the human body includes the formation of fibrinogen which is important for blood clotting. Ca deficiency can also lead to rickets in children. Magnesium as well is an essential element known to play an important role in a number of enzymes that are involved in the oxidative phosphorylation in human body. Its also known to be responsible for bone mineralization, protein building, nerve impulse transmission and also maintenance of teeth. The mean concentration of Magnesium is 333.63 mg/kg. Mg was detected in 8 of the 20 samples studied in this work. The concentrations of manganese were found to range from 2.27 mg/kg to 15.66 mg/kg. Manganese is a component of the antioxidant enzyme superoxide dismutase and is also involved in energy metabolism and urea formation. Al was also present at low concentration with its highest concentration found in BF1 with a concentration of 0.97 mg/kg. Al may meddle with some cells of the nervous system and other tissues. The presence of Aluminum may be due to the raw materials used in making the dough or from the pans used for baking the bread since they are manufactured from Aluminum.

The precision and accuracy of the method is evaluated by analysis of standard reference material from the National Institute of Standards and Technology, SRM 1567 (wheat flour) under the same conditions. The full results of the evaluation are presented in table 3.

Table 1: This table shows the concentrations of Anti Nutritional Factors in Bread Samples

Sample ID	Hydrocyanic Acid (mg/100 g)	Oxalates (mg/100 g)
AB 1	3.08 ± 0.12	18.65 ± 0.15
LTB 1	-	15.58 ± 0.02
CN 1	-	15.12 ± 0.23
LQ 1	-	15.15 ± 0.33
HY 1	5.62 ± 0.01	17.25 ±0.24
BA 1	-	16.21 ± 0.65
AC 1	15.77 ± 0.12	16.41 ± 0.30
AQ 1	-	19.31 ± 0.20
SRB 1	18.36 ± 1.02	15.48 ± 0.22
AS 1	3.46 ± 0.02	15.98 ± 0.14
BB 1	7.94 ± 0.17	15.11 ± 0.15
SQ 1	1.73 ± 0.02	17.75 ± 0.50
MA 1	3.40 ± 0.02	15.75 ± 0.11
BE 1	-	17.25 ± 0.42
AH 1	5.78 ± 0.21	15.15 ± 0.12
BF 1	-	17.52 ± 0.23
S 1	-	15.68 ± 0.13
GC 1	-	15.32 ± 0.20
M 25	4.27 ± 0.12	15.25 ± 0.11
HG 1	4.91 0.11	14.49 ± 0.22
HTB 1	18.58 ±1.23	13.15 ± 0.23
NB 1	6.97 ± 0.08	9.99 ± 0.05
CB 1	1.19 ± 0.01	12.45 ± 0.12
HB 1	3.56 ± 0.06	10.75 ± 0.02
RD 1	-	13.99 ± 0.12
PB 1	-	21.91 ± 0.23
LT 1	-	6.66 ± 0.02

Table 2: This table shows the elemental Contents in bread samples

Sample ID	Na (%)	K(%)	Cl (%)	Ca (%)	Cu (mg/kg)	Al (mg/kg)	Mn (mg/kg)	Mg (mg/kg)
AB 1	0.40 ± 0.02	0.16 ± 0.002	0.6 ± 0.01	0.18 ± 0.01	1.04 ± 0.07	0.39 ± 0.01	BDL	BDL
LTB 1	0.30 ± 0.01	0.17 ± 0.001	0.51 ± 0.01	0.11 ± 0.01	BDL	0.67 ± 0.02	2.98 ± 0.29	BDL
CN 1	0.24 ± 0.01	0.33 ± 0.02	0.40 ± 0.01	0.10 ± 0.01	BDL	0.34 ± 0.01	15.66 ± 1.39	585 ± 54
LQ 1	0.17 ± 0.01	0.10 ± 0.01	0.50 ± 0.02	0.25 ± 0.02	BDL	0.41 ± 0.01	2.83 ± 0.25	BDL
HY 1	0.30 ± 0.01	0.13 ± 0.01	0.48 ± 0.02	0.18 ± 0.02	BDL	0.40 ± 0.02	4.63 ± 0.45	283 ± 24
BA 1	0.34 ± 0.03	0.11 ± 0.01	0.50 ± 0.02	0.31 ± 0.02	0.52 ± 0.03	0.41 ± 0.02	BDL	BDL
AC 1	0.16 ± 0.02	0.10 ± 0.01	0.40 ± 0.04	0.16 ± 0.01	BDL	0.65 ± 0.02	5.41 ± 0.51	221 ± 20
AQ 1	0.34 ± 0.02	0.24 ± 0.02	0.54 ± 0.02	0.09 ± 0.01	BDL	0.28 ± 0.02	11.11 ± 1.07	321 ± 24
SRB 1	0.31 ± 0.02	0.16 ± 0.02	0.51 ± 0.01	0.37 ± 0.03	BDL	0.57 ± 0.01	8.01 ± 0.72	BDL
BB 1	0.33 ± 0.01	0.18 ± 0.01	0.54 ± 0.01	0.16 ± 0.01	BDL	0.32 ± 0.02	5.70 ± 0.49	230 ± 20
SQ 1	0.42 ± 0.03	0.20 ± 0.02	0.58 ± 0.01	0.14 ± 0.01	BDL	0.31 ± 0.01	2.27 ± 0.19	BDL
MA 1	0.26 ± 0.02	0.24 ± 0.02	0.31 ± 0.01	0.20 ± 0.01	BDL	0.66 ± 0.03	9.46 ± 0.85	301 ± 27
BE 1	0.40 ± 0.01	0.16 ± 0.01	0.63 ± 0.01	0.31 ± 0.03	BDL	0.67 ± 0.02	8.26 ± 0.80	BDL
AH 1	0.36 ± 0.02	0.17 ± 0.01	0.56 ± 0.01	0.36 ± 0.03	0.57 ± 0.05	0.49 ± 0.02	8.63 ± 0.83	325 ± 32
BF 1	0.32 ± 0.02	0.12 ± 0.01	0.48 ± 0.01	0.17 ± 0.01	BDL	0.97 ± 0.01	BDL	BDL
S 1	0.42 ± 0.03	0.17 ± 0.02	0.60 ± 0.03	0.21 ± 0.02	BDL	0.32 ± 0.01	3.17± 0.30	BDL
GC 1	0.26 ± 0.02	0.12 ± 0.01	0.50 ± 0.03	0.17 ± 0.01	BDL	0.38 ± 0.02	6.55 ± 0.47	403 ± 35
M 25	0.21 ± 0.01	0.10 ± 0.01	0.54 ± 0.03	0.13 ± 0.01	BDL	0.35 ± 0.01	4.78 ± 0.30	BDL
HTB 1	0.28 ± 0.02	0.10 ± 0.01	0.43 ± 0.01	0.27 ± 0.02	BDL	0.87 ± 0.03	2.45 ± 0.19	BDL
CB 1	0.26 ± 0.02	0.20 ± 0.02	0.36 ± 0.01	0.19 ± 0.02	BDL	0.50 ± 0.02	3.34 ± 0.30	BDL

Table 3: This table shows the concentrations of some analyzed elements in the certified reference material

Element	This Work	Reported
Ca (%)	0.02 ± 0.001	0.019 ± 0.001
Cu (µg/g)	1.93 ± 0.02	2.1 ± 0.3
K (%)	0.132 ± 0.01	0.136 ± 0.004
Mn (µg/g)	7.98 ± 0.21	8.5 ± 0.5
Na (µg/g)	8.2 ± 0.55	8.0 ± 1.5

CONCLUSIONS

The results obtained established that Na, K, Cl, Ca were present at high concentrations in all the samples analyzed. Mg and Mn were present in most of the samples that were evaluated with the exception of Cu which was present in only 3 of the samples analyzed. The anti nutritional content was determined in mg/100g dry weight basis. The hydrocyanic acid and oxalates contents were within acceptable limits.

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CONFLICT OF INTEREST
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