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Trace and Macro Elements Concentrations in Selected Fresh Fruits, Vegetables, Herbs, and Processed Foods in North Carolina, USA

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Abstract

Fresh fruits, vegetables, herbs, and processed foods continue to be the major sources of essential trace elements in humans' diet required for proper body development. However, food products can potentially be contaminated by toxic heavy metals (HMs) from environmental contamination or industrial food processing. The deleterious health implications of essential trace and macro elements' deficiency and toxic consequences of HMs in humans necessitate proactive monitoring of the essential trace elements and HMs concentrations in the humans diet to ensure public health safety. Accordingly, this study investigated a comparative analysis of essential elements and potential toxic HMs concentration in food products in the Greensboro metropolis, North Carolina, USA. A total of 49 food samples comprising of 16 difference fresh fruits, 17 fresh vegetables, 4 herbs, and 12 processed foods were purchased from local grocery stores and analyzed for iron (Fe), calcium (Ca), magnesium (Mg), nickel (Ni), zinc (Zn), copper (Cu), lead (Pb), cadmium (Cd), and chromium (Cr) by the use of flame atomic absorption spectrometry (FAAS). The concentrations of elements were subjected to a regression analysis to further gain insight of the inter-element association in the food samples. The results of the study showed high variability in the concentrations of elements in the fresh fruits, vegetables, herbs, and processed foods. The overall average concentrations of Ca (1501 μg/g), Mg (186.5 μg/g), Fe (55.8 μg/g), Zn (22.2 μg/g), Pb (10.2 μg/g), Cu (5.8 μg/g), Cr (<0.1 μg/g), Cd (<0.1 μg/g), and Ni (<0.04 μg/g) were obtained in all food samples categories. The elements concentrations were generally poorly correlated in the food samples. However, a strong inter-element association between Cu and Fe concentration (R^2 = 1.000) and a weak association between Ca and Fe (R^2 = 0.5609) were found in the food samples. A survey questionnaire was administered to 396 participants in the Greensboro metropolis to evaluate the food consumption pattern and a daily/weekly dietary estimate intake of vegetables, fruits, herbs and processed foods. The results of the food survey analysis showed that the amount

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of vegetables, fruits, herbs, and processed foods dietary intake varied widely. In general, the participants consumed more processed foods than vegetables, fruits, and herb foods. The low dietary intake of vegetables, fruits, herbs suggests that most participants may be obtaining insufficient essential trace elements and other vital nutrients necessary for normal growth and body development in their diet.

Keywords

Foods Trace-Elements-Analysis, Atomic-Absorption Spectroscopy, Inter-Element-Association, Daily/Weekly-Dietary Intake Estimate, Foods-Consumption-Pattern-Recognition

1. Introduction

Fresh fruits, vegetables, herbs, and processed foods are major sources of essential trace elements in the human diet and are required for proper growth and body development [1]. Essential trace elements are required in trace amounts in the humans body for biochemical and physiological functions [1]-[5]. For instance, zinc (Zn) plays a significant role as a co-enzyme for carboxyl peptidase, liver alcohol dehydrogenase, and carbonic anhydrase [4] [6]. Copper (Cu) is required for redox enzymes cytochrome oxidase [4] [7] [8]. Iron (Fe) is also a trace element found in the heme proteins hemoglobin and myoglobin [4] [9] [10]. A relatively small amount of Ni is required to aid in the absorption of Fe in the body. However, high Ni concentrations can interfere with Zn, magnesium (Mg), and calcium (Ca) utilization and metabolism [4] [11]. Other elements such as Ca and Mg are essential macro-elements required for bone structure development and necessary for carbohydrate and protein metabolism [1] [2] [4]. Calcium and Mg are also required in fairly large amounts to maintain body electrolytes and tissue homeostasis [2] [4]. Trace element deficiencies in humans have been associated with weak bone and teeth development, mental retardation, child developmental issues, anemia, insomnia, decreased immune function, and other health related complications [4] [7] [8] [12]-[15]. Increased intake of fruits, vegetables, and fresh herbs are also vital to maintain propernutrition as they are good sources of fiber, antioxidants, and vitamins [7] [16]-[18].

However, food crops, and processed foods can potentially be contaminated by toxic heavy metals (HMs) from environmental contamination or during industrial food processing. For instance, food crops can be contaminated through absorption and bioaccumulation of HMs from contaminated soils, fertilizers, and contaminated water sources used for irrigation [3] [6] [7] [16] [17] [19]-[28]. Food products can also be contaminated by leakage of HMs from food packaging materials or through cross-contaminations during industrial food processing [1] [26]-[28]. Unlike essential trace elements, HMs have no nutritional value and are non-biodegradable. Heavy metals can also be bio-accumulated and biomagnified in several organs such as the kidneys and cardiovascular system [24]-[27] [29] [30]. Elevated concentrations of HMs in humans have been associated with chronic and acute health issues such as cancer diseases, depression, hematic, gastrointestinal and renal failure, osteoporosis, tubular and glomerular dysfunctions, femoral pain, skeletal deformations, and low intelligent quotients in children [1] [4] [7] [10] [26] [31] [32]. Humans can potentially be exposed to HMs poisoning through various routes, including the consumption of HMs contaminated foods, industrial and environmental pollution, or occupational exposure [1] [4] [7] [26] [28] [33].

Heavy metals contamination is more prevalent in underdeveloped and developing countries due to inefficient food regulatory policies, inadequate environmental monitoring, and enforcement strategies. However, the current distribution of food crops is global and is not limited by borders. The health implications of deficiencies in-essential trace elements and the toxic consequences of HMs in humans necessitate effective monitoring of both essential trace elements and HMs concentrations in food products to ensure the public health safety. It is also important to focus on proper food quality assurance and quality control protocols that ensure the intake of adequate amounts of essential trace elements while preventing the consumption of HMs in food products [3] [6] [19]-[22] [27] [28] [34]. Accordingly, this study investigated the essential trace elements and potentially toxic HMs (Fe, Ca, Mg, Ni, Zn, Cu, Cr, Pb, and Cd) concentrations in selected fresh fruits, vegetables, herbs products, and processed foods in Greensboro, North Carolina, USA. The inter-element association in the food samples was also investigated. The trace elements and HMs concentrations in this study were further compared to the concentrations of these elements in food products from other countries. In addition, a voluntary survey questionnaire was administered to 396 participants in the Greensboro metropolis to further evaluate the food consumption pattern and to estimate the daily/weekly dietary intake of vegetables, fruits, herbs and processed foods. The participants' age ranged between 15 and 39 years. The survey questionnaire did not contain any personal data or information to protect the identity of the participants.

2. Material and Methods

2.1. Food Sample Collection and Sample Preparation

A total of 49 food samples comprising of 16 fresh fruits, 17 fresh vegetables, 4 herbs, and 12 processed foods shown in **Table 1** were purchased at local grocery store in Greensboro, NC. The food samples were placed in previously nitric acid washed plastic bags and immediately refrigerated prior to laboratory analysis to protect the food sample integrity and to prevent food sample decomposition or microbial growth. The food samples were diced into small pieces, placed in sterilized crucibles, and oven dried (Fisher Scientific Isotemp oven) at 55˚C for approximately 24 hours. The oven dried food samples were subsequently ground with mortar and pestle. A known weight of each dried food sample was digested with 6M HNO_3 (trace element grade, Fisher, NY) solution in a digestion flask for approximately 5 - 6 hours to ensure complete sample digestion. The nitric acid digested food samples were cooled to room temperature, filtered with Whatman filter paper and diluted to the mark with de-ionized water in a 50-ml volumetric flask. The statistical data analysis, regression analysis, and pattern recognition of inter-element association in the food samples for were performed using chemometric software (The Unscrambler, CAMO Inc., 9.4).

Table 1. Food samples and food category.

Food category			
Fresh fruits	Fresh vegetables	Herbs	Processed foods
Korean pear	Batata yam	Moringa	Self-rising flour
Bosc pear	Idaho potato	Fleur de Jamaica	Yellow cake mix
Dragon fruit	Korean sweet potato	Ginger	Buttermilk pancake mix
Ataulfo Mango	Purple potato	Garlic	Instant oatmeal
Guava	American yam		Cornbread mix
White nectarine	American okra		Instant mashed potatoes
White peach	Chinese okra		Baby rice cereal
Apricot	Mamey Sapote		Instant grits
Kiwi	Purple yam		Gelatin dessert
Dried coconut	White potato		Infant powdered baby formula
White coconut	Red potato		
Bartlett pear	Cali red potato		
Tomatillo Milpero	Chayote squash		
Chinese bitter	Thai eggplant		
Melon	White yam		
Indian bitter melon	Yellow yam		
Plantains	Thai okra		

2.2. Calibration Curve, Trace Element Analysis, and Statistical Data Analysis

Working range standard solutions of Pb, Cd, Ca, Mg, Ni, Zn, Cu, Cr, and Fe were prepared by serial dilution of 1000 μg/g standard stock solution of each element. The standard and the sample solutions were subjected to flame atomic absorption spectrometric (FAAS) analysis using the flame atomic absorption spectrometer (Thermo Scientific, ICE 3000 series).A calibration curve was constructed for each element by plotting the absorbance of each element versus the element concentration. The constructed calibration curves were subsequently utilized to determine the concentration of each element in the food samples.

3. Results and Discussion

3.1. Calibration Curves

The summary of the calibration curve parameters showing the linear regression equations, the square correlation coefficient (R^2) values, wavelengths of detection, limits of detection (*LOD*), and limits of quantification (*LOQ*) for each element analyzed is presented in **Table 2**. The *LOD* and *LOQ* was determined as 3 s/m and 10 s/m, respectively, where s is the standard deviation of the absorbance of the triplicate blank solution analysis and m is the slope of the calibration curve for each element. The obtained R^2 values of the calibration curves ranged between 0.934 for Fe and 0.9991 for Cu. The high R^2 values demonstrate high linear correlations between the absorbance and element concentrations. The *LOD* ranged between 0.01 μg/g for Pb and 0.6 μg/g for Ca. However, the values of *LOQ* ranged between 0.4 μg/g and 1.9 μg/g for Pb and Ca, respectively.

3.2. Overall Trace Elements Concentrations in Food Samples

The overall concentrations of the elements in all food samples are shown in **Table 3**. The concentrations of Ca in all food samples ranged between 97 μg/g and 4970 μg/g, with an overall average Ca concentration of 1501 μg/g. As expected, the highest average Ca concentration was observed in processed infant formula, with an average Ca concentration of 4970 μg/g. The highest concentration of Fe from all food samples was also found in processed foods, with a maximum Fe concentration of 367 μg/g. High Fe concentrations in the processed foods is expected as several sample packages denoted the samples were fortified with Fe on the label. The overall concentrations of Mg ranged between 18 μg/g and 236.8 μg/g, with an overall average Mg concentration of 186.5 μg/g in all food samples. Relatively much lower average concentrations of 55.8 μg/g, 22.2 μg/g, 10.2 μg/g, and 5.8 μg/g were obtained for Fe, Zn, Pb, and Cu, respectively. The overall concentrations of Cr, Cd, and Ni were below the detection limit of 0.1 μg/g, 0.1 μg/g and 0.04 μg/g, respectively. The highest concentrations of Cu, Fe, Pb, Zn, and Mg were found in apricot, moringa, yellow yam, American okra, and Chinese okra, respectively. On the contrary, the lowest concentrations for Ca, Cu, Pb, Zn, and Mg were found in plantains, Mamey-Sapote, American yam, and Good Start baby formula, respectively.

Table 2. Calibration curve, variable an parameters.

Metal	Regression equation ($y = mx + b$)	R^2	Wavelength (nm)	*LOD* (μg/g)	*LOQ* (μg/g)
Mg	$y = 0.53224x + 0.0107$	0.9966	285	0.0169	0.0564
Zn	$Y = 0.07834x + 0.1288$	0.9340	214	0.1914	0.6382
Fe	$y = 0.02921x + 0.0048$	0.9936	248	0.0308	1.027
Cu	$y = 0.04612x + 0.0022$	0.9991	325	0.0650	0.2168
Ca	$y = 0.02088x + 0.0202$	0.9718	423	0.5747	1.916
Pb	$y = 0.02371x - 0.0071$	0.9858	217	0.0127	0.0422
Cr	$y = 0.02525x + 0.0189$	0.9864	358	0.1188	0.3960
Cd	$y = 0.07021x + 0.0859$	0.9638	229	0.1282	0.4273
Ni	$y = 0.03193x + 0.0102$	0.9970	232	0.0376	0.1253

Table 3. Overall average trace elements concentrations in all food samples.

	Elements concentration (μg/g)								
	Ca	Cu	Fe	Pb	Zn	Cr	Cd	Mg	Ni
Average	1501	5.8	55.8	10.2	22.2	<0.1	<0.1	186.5	<0.04
Maximum	4970	58.8	667.8	14.3	92.0	<0.1	<0.1	236.8	<0.04
Minimum	97.1	0.29	0.1	7.1	0.17	<0.1	<0.1	18.1	<0.04

3.3. Trace Elements Concentrations in Different Classes of Food Categories

3.3.1. Trace Elements Concentrations in Fruit Samples

The concentrations of elements in the fruit samples category are shown in **Table 4**. An overall average concentration of Ca (1024 μg/g), Mg (191.7 μg/g), Zn (15 μg/g), Fe (13 μg/g), and Cu (6.2 μg/g) were recorded in the fruit sample category. The concentrations of Ca found in the fruit samples were comparatively larger than the concentrations of Fe and Mg in the fruit samples. The highest Ca concentration was obtained in the Momordica group; containing Chinese and Indian bitter melons, kiwi, Ataulfo mango, and Dragon fruit. The highest concentrations of Ca, Cu, Fe, Zn, and Mg were found in apricot, white coconut, and Ataulfo mango. However, relatively low average concentrations of Ca, Cu, Fe, Pb, Zn, and Mg were detected in plantains, Indian bitter melon, and Bartlett pear. The concentrations of Cr, Cd, and Ni were below the detection limits of 0.1, 0.1 and 0.04 μg/g, respectively. An overall average Pb concentration of 10 μg/g was found in the fruit samples category. The highest Pb concentration was found in white coconut (13.4 μg/g) while the lowest Pb concentration of 4.1 μg/g found in Chinese bitter melon. An average Pb concentration of 6.98 μg/g in melon obtained in this study was much lower than the reported 19.2 μg/g Pb level in melon from Algeria but it is comparable to the average Pb concentrations of 9.2 μg/g and 10 μg/g found in fruits elsewhere [35]. Lead is naturally present in the earth crust in trace amounts. The low Pb concentrations detected in fruits could be due to natural absorption of Pb from soil. However, Pb bioaccumulation from irrigation practices and/or food transported from other countries may also be contributing to the levels of Pb detected in the food samples.

3.3.2. Trace Elements Concentrations in Vegetable and Herbs Products

The range and the average elements concentrations in vegetables and herbs foods are presented in **Table 5**. Once again, the element concentrations are widely varied as demonstrated by the large range of concentrations of elements in the vegetables and herbs food samples. The average concentration of Ca (1490 μg/g), Mg (191 μg/g), Fe (60 μg/g), Zn (25 μg/g), and Cu (6.8 μg/g), was obtained in the vegetables and herbs food category. The concentrations of Ni, Cr and Cd were also below the detection limit of 0.04 μg/g, 0.1 μg/g in the vegetables and herbs food samples. An overall average Pb concentration in vegetable and herbs foods category was 11 μg/g. The highest Pb concentration of 27 μg/g was found in ginger. However, the lowest Pb concentration of 9.0 μg/g was recorded in Thai okra. The Pb concentrations in potatoes are comparatively lower than the Pb detected in the food samples in Algeria [35] but higher than those found in the food samples in China [36], Spain [37], Pakistan [38], and Brazil [39]. The Pb concentrations in okra found in this present study are comparable to 10.7 μg/g Pb reported in Turkey [40] but lower than the 25 μg/g Pb concentrations reported in foods samples found in India [18]. The concentrations of Cu found in okra and eggplant in this study were approximately three times smaller than the concentrations of Cu reported in okra food samples in Turkey. However, the Zn concentrations found in eggplant in this study are similar to the Zn concentrations in eggplant from Turkey [40] and Egypt [3].

3.3.3. Trace Elements Concentrations in Processed Foods

The investigated processed foods in this study includes, self-rising flour, yellow cake mix, buttermilk pancake mix, instant oatmeal, cornbread mix, instant mashed potatoes, baby rice cereal, instant grits, gelatin dessert, and infant baby formula. This class of foods continued to be the major sources of nutrients and essential elements both to the infants, babies, and adults. The overall summary of the concentrations of trace elements determined in the processed foods are shown in **Table 6**. Overall high average Ca (2159 μg/g), Mg (172 μg/g), and Fe (106 μg/g) concentrations were found in the processed foods. However, the average concentrations of Zn (27 μg/g) and Pb (9.2 μg/g) was found in the processed foods. The highest Fe concentration of 367 μg/g was found in

Table 4. Summary of the average trace elements concentrations in fruits.

	Elements concentration (μg/g)								
	Ca	Cu	Fe	Pb	Zn	Cr	Cd	Mg	Ni
Average	1024	6.2	13	10	15	<0.1	<0.1	191.7	<0.04
Maximum	2348	30	36	13	37	<0.1	<0.1	204.3	<0.04
Minimum	339	1.4	1.1	4.1	5.7	<0.1	<0.1	167.8	<0.04

Table 5. Summary of the average trace elements concentrations in vegetables and herbs.

	Elements concentration (μg/g)								
	Ca	Cu	Fe	Pb	Zn	Cr	Cd	Mg	Ni
Average	1490	6.8	60	11	25	<0.1	<0.1	191	<0.04
Maximum	4006	16	387	27	65	<0.1	<0.1	213	<0.04
Minimum	132	2.3	0.76	9	1.7	<0.1	<0.1	97	<0.04

Table 6. Summary of the average trace elements concentrations in processed foods.

	Elements concentration (μg/g)								
	Ca	Cu	Fe	Pb	Zn	Cr	Cd	Mg	Ni
Average	2159	3.4	106	9.2	27	<0.1	<0.1	172	<0.04
Maximum	3884	8.4	367	11	47	<0.1	<0.1	197	<0.04
Minimum	777	0.6	1.4	4.8	7.4	<0.1	<0.1	116	<0.04

infant baby formula.

3.4. Inter-Element Associations in Food Samples

The trace element concentrations in the food samples were subjected to regression analysis to further gain insight of the inter-element associations in the food samples. Table 7 presents the summary of the square correlation coefficients (R^2) of the inter-element associations in the food samples. The trace element concentrations were generally poorly correlated in the food samples. However, a strong association between Cu and Fe (R^2 = 1.000) and a weak association (R^2 = 0.5609) was observed between Ca and Fe in the food samples. The observed association between Cu and Fe and between Ca and Fe cannot be fully explained; however, the associations suggest a common source of these elements, possibly from the soil. Associations between the elements also suggest that peoples who consume these food items will likely be obtaining Cu, Fe, and Ca simultaneously in their diet.

3.5. Quality Control, Analytical Method Validation, and Recovery Study

All necessary precautions were observed to ensure the accuracy and reliability of the results of trace element analysis in this study. First, the food samples were immediately refrigerated prior to sample analysis to prevent sample decomposition or microbial growth. The trace element grade nitric acid with a purity grade of 99.999% was also used for food digestion and standard solution preparation. All glassware were pre-soaked in 6M HNO_3 for three days and thoroughly rinsed with de-ionized water before use to remove impurities and contaminants. The food sample preparations were performed in a clean and dust free laboratory to eliminate possible sample contamination of the food samples during sample preparation. All trace-element sample analyses were blank subtracted. Each food sample was analyzed in triplicate and the averages of the triplicate samples were reported.

To further ensure the quality assurance and accuracy of the concentrations of the elements in the food samples, new sets of the same fresh fruits, vegetables, and herbs food samples were purchased from the same local grocery store approximately 30 days after the initial food sampling and analysis. The new set of the food sample

Table 7. Inter-element associations (square correlation coefficient, R^2) in all food samples.

	Ca	Cu	Fe	Pb	Zn	Mg
Ca		0.0032	**0.5609**	0.0138	0.3425	0.0107
Cu	0.0032		**1.000**	0.0174	0.0492	0.1675
Fe	**0.5609**	**1.000**		0.0174	0.0492	0.1675
Pb	0.0138	0.0174	0.0174		0.0342	0.0233
Zn	0.3425	0.0492	0.0492	0.0342		0.1307
Mg	0.0107	0.1675	0.1675	0.0233	0.1307	

collections were re-analyzed using the same food digestion and analytical protocol utilized previously for each element. The results of the elements concentrations in the initial food analysis favorably compared with the elements concentrations in the new set of the food samples, demonstrating the precision and accuracy of the analytical protocol for trace elements analysis in the food samples.

A spiked recovery was further conducted to evaluate the accuracy of the analytical protocol for trace element analysis. There were ten randomly selected and already analyzed food samples spiked with known concentrations of each element standard. The spiked food samples were taken through the entire nitric acid food digestion and FAAS trace element analysis as previously described. The recoveries of the metals in the spiked food samples were evaluated by comparing the concentrations of the spiked metal with the concentrations detected from the spiked samples using FAAS spectrometry. The average percent spike recovery was calculated using a standard protocol [41]. The calculated percent recovery study for the elements was within the acceptable 80% - 120% recovery range, further validating the results of this study.

3.6. Daily/Weekly Dietary Intake Estimate of Vegetables, Fruits, Herbs and Processed Foods

The results of the survey questionnaire analysis of the daily/weekly dietary intake estimate of vegetable, fruits, herbs and processed foods are shown in **Table 8**. The vegetable, fruit, herb and processed foods daily/weekly dietary intake estimate patterns of the participants were very similar irrespective of their age or sex. Also, the daily/weekly dietary intake estimates varied widely. In general, the participants consumed more potatoes and processed foods than any other food items. The participants reported a daily/weekly dietary intake of 48.9% for Idaho potatoes, 35.6% for white potatoes, and 40.7% for buttermilk pancake mix. Approximately 37% of the participants reported a daily/weekly dietary intake of instant grits while 31.0% of the participants reported a daily/weekly consumption of classic cornbread. Approximately 29.2%, 26.7%, and 22.5% of the participants reported a daily/weekly dietary intake of instant oatmeal, self-rising flour, and instant mashed potatoes, respectively. Also, 16.7%, 20.7%, 25.8%, 28.8%, and 37.2% of the participants reported a daily/weekly dietary intake of American okra, plantain, ginger, kiwi, and garlic, respectively. However, the daily/weekly dietary intake estimate of other fruits and vegetables were very poor. The low daily/weekly dietary intake of vegetables, fruits, herbs suggests that most participants may be obtaining insufficient amounts of essential trace elements and other vital nutrients values necessary for normal growth and body development. However, the participants may obtain essential trace elements from other food sources and food supplements.

4. Conclusion

The concentrations of essential and potentially toxic elements in fresh fruits, vegetables, fresh herbs, and processed foods in the Greensboro, NC metropolis were investigated to assess a potential risk of consumer exposure to toxins through food consumption. The concentrations of trace elements obtained in this study were generally within the normal trace element concentrations for food samples [42]-[45]. Potentially toxic heavy metals such as Cd, Ni, and Cr were not detected in any of the food samples. The concentrations of Pb detected in some food samples are within the acceptable range of Pb concentrations for food samples. Strong correlations between Cu and Fe and between Ca and Fe were obtained in the food samples. The trace element concentrations in this study are also comparable to the concentrations of elements in food samples from other countries. Overall, the ana-

Table 8. The daily/weekly dietary intake estimate of vegetables, fruits, herbs and processed foods.

Food Item	Participants				
	15 - 24 years (n = 360)	25 - 35 years (n = 36)	Female (n = 259)	Male (n = 146)	Overall
White Coconut	8.9	5.6	8.8	8.2	7.3
Guava	4.7	2.8	5.0	3.4	3.8
Ataulfo Mango	11.4	11.1	12.4	8.9	11.3
Tomatillo Milpero	1.1	5.6	0.4	2.7	3.4
Apricot	5.3	2.8	6.2	3.4	4.1
Bosc Pear	6.9	8.3	6.6	8.9	7.6
Bartlett Pear	7.2	11.1	6.6	11.6	9.2
Plantains	16.4	25	17.4	16.4	20.7
White Nectarine	3.6	0	3.5	2.7	1.8
Indian Bitter Melon	0.3	0	0	0.7	0.2
White Peach	9.7	0	10.4	8.2	4.9
Dragon Fruit	3.9	0	3.5	3.4	2.0
Dried Coconut	6.1	2.8	6.6	4.1	4.5
Kiwi	29.7	27.8	33.6	21.2	28.8
Korean Pear	0.6	2.8	0.8	0.7	1.7
Chinese Bitter Melon	0.3	0	0	0.7	0.2
Idaho Potato	45	52.7	42.9	52.0	48.9
Batata Yam	4.7	5.6	4.3	5.5	5.2
Korean Sweet Potato Yam	3.6	13.9	3.9	5.5	8.8
Ginger	18.3	33.3	19.3	21.9	25.8
Purple Potato	5.3	2.8	3.9	6.8	4.1
American Yam	23.6	27.8	22.8	26.7	25.7
American Okra	16.7	16.7	18.1	15.1	16.7
Chinese Okra	2.2	0	1.9	2.1	1.1
Sapote	0.6	0	0	1.4	0.3
Fleur de Jamaica	1.1	0	0.7	1.4	0.6
Purple Yam	1.1	0	0.4	2.1	0.6
White Potato	35	36.1	33.2	39.0	35.6
Cali Red Potato	4.2	2.8	4.6	3.4	3.5
Red Potato	22.8	30.6	23.9	21.9	26.7
Chayote Squash	3.1	2.8	2.7	4.1	3.0
Garlic	27.2	47.2	29	31.5	37.2
Thai Eggplent	2.5	2.8	1.5	4.8	2.7
White Yam	1.9	0	0.8	3.4	1.0
Yellow Yam	1.9	2.8	1.9	2.1	2.4
Thai Okra	1.1	0	1.2	0.3	0.6
Moringa	0.6	0	0.4	0.7	0.3

Continued

Instant Grits	37.5	36.1	35.1	39.7	36.8
Yellow Cake Mix	32.5	16.7	35.1	23.3	24.6
Enfamil Lipil	0	0	0	0	0
Good Start	0	0	0	0	0
Baby Rice Cereal	1.7	0	0.8	2.7	0.9
Gelatin Dessert	11.7	13.9	12.4	10.3	12.8
Instant Mashed Potatoes	31.1	13.9	30.9	26.7	22.5
Similac Advance	0	0	0	0	0
Instant Oatmeal	33.3	25	35.5	26.7	29.2
Buttermilk Pancake Mix	45.3	36.1	44.4	43.8	40.7
Classic Cornbread	36.9	25	37.1	33.6	31.0
Self-Rising Flour	22.8	30.6	25.1	21.9	26.7

lyzed food samples contained adequate essential trace elements concentrations required in humans diet. There is no evidence of heavy metal food contamination that can endanger the public safety or pose health risk to food consumers in the Greensboro metropolis. However, the small Pb concentrations detected in the food samples necessitate a continuous monitoring of the levels of Pb in food samples to ensure public safety. The daily/weekly dietary intake estimate of vegetables, fruits, herbs and processed foods were investigated to evaluate the food consumption of the residents. The participants generally consumed more potatoes and processed foods than any other investigated fruits and vegetables. Future study includes analysis of food samples for other potentially dangerous elements such as mercury and arsenic.

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