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Mineral Contents of Some Canned, Jarred, and Packaged Foods Commonly Consumed in South-East Nigeria

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HIGHLIGHTS

- Ca was the most abundant micronutrient in all samples. Na was the scarcest micronutrient.
- Ca and Mg were within the national standard in milk and milk products.
- The Na, K, Ca, and Mg contents were lower than the international reference value.
- Some efforts are necessary to improve the nutritional quality of foods distributed in Nigeria.

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Acronyms and abbreviations
FAAS=Flame Atomic Absorption Spectrometer
RDA=Recommended Daily Allowance

ABSTRACT

Background: Minerals are required for human body to function properly. The purpose of this study was to find if these canned, jarred, and packaged foods are a good source of sodium (Na), calcium (Ca), magnesium (Mg), and potassium (K) in Nigerian diets.

Methods: Totally, 188 samples of canned, packaged, and jarred foods were collected from malls, local markets, and street vendors; and then they were divided into eight food groups. After microwave-assisted digestion; the Na, K, Ca, and Mg contents of canned, packaged, and jarred foods commonly consumed in South-East Nigeria were determined using micro-sampling Flame Atomic Absorption Spectrometry. The results obtained were subjected to ordinary statistical analysis and presented as box plots. All statistical analysis was done using the Statistical Package for Social Sciences, version 20 software.

Results: Ca was the most abundant micronutrient in all samples, reaching levels above 0.7 g/100 g in the milk and milk products group, followed by Mg at levels above 0.2 g/100 g. Na was the scarcest micronutrient with levels ranging from 0.040 to 0.065 g/100 g across food groups. K level also varied reaching levels above 0.070 g/100 g in the beverages (alcoholic and non-alcoholic). The mean concentration (g/100 g) of Ca (0.782±0.313) and Mg (0.202±0.044) in milk and milk products were within the national reference standard by National Agency for Food and Drug Administration and Control for such micronutrients. However, the Na, K, Ca, and Mg concentrations of the various food groups were all lower than the international standards.

Conclusion: It is concluded that some efforts are necessary to improve the nutritional quality of canned, jarred, and packaged foods distributed in Nigeria.

Introduction

Minerals are necessary for biological processes and play an important role in metabolic functions, normal growth, and development. Calcium (Ca), magnesium (Mg), sodium (Na), and potassium (K) are the most

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important macrominerals physiologically. The primary functions of these minerals are to maintain pH, osmotic pressure, nerve conductance, muscle contraction, energy production, and nearly all other aspects of biological life (Chekri et al., 2012). As a result, health problems can be attributed to insufficient dietary intake, which results in a deficiency or excess of these elements. The significance of optimal intakes of essential mineral elements in maintaining peak health is thus widely acknowledged (Chekri et al., 2012).

Na is a nutritionally essential which role in the human body is to maintain electrolyte and water balance. It is also necessary for nerve and muscle function (WHO, 2005). On the other hand, excessive Na intake might result in noncommunicable diseases, particularly cardiovascular disease (Mozaffarian et al., 2014). According to a recent study, salt or Na intake may be a risk factor for obesity, which is another major public health concern (Ma et al., 2015). Data from around the world indicate that the population's average Na consumption is well above the minimal physiological needs, and in many countries exceeds the 2 g Na/day (equivalent to 5 g salt/day) value recommended by the 2002 joint World Health Organization/Food and Agriculture of the United Nations (WHO/FAO) expert consultation (Brown et al., 2009).

K is a nutrient that has an impact on many processes in the human body by performing a variety of biological functions. It is a cofactor that participates in protein synthesis, enzyme activation, water balance, and thus affects osmosis (Soetan et al., 2010). It is required for the secretion of insulin, the phosphorylation of creatine, and the metabolism of carbohydrates. K-rich diets have been linked to lower blood pressure (Palmer and Clegg, 2020), lowering the risk of stroke (Akita et al., 2003; DeSalvo et al., 2016; Palmer and Clegg, 2020), enhancing bone health, and decreasing the risk of nephrolithiasis (DeSalvo et al., 2016). Healthy adults are advised to consume at least 3,510 mg of K per day to prevent high blood pressure and cardiovascular disease (WHO, 2012).

Approximately 2% of an adult's body weight, or 1,200 g of Ca, makes up the majority of the body's mineral elements (Theobald, 2005). The skeleton and teeth contain the majority of Ca as hydroxyapatite, which provides rigidity. The rest is found in soft tissues and bodily fluids and accounts for less than 1% of total body Ca (Theobald, 2005). Ca is a mineral that is involved in a variety of vital functions (Cormick and Belizán, 2019). Ca is a necessary nutrient not only for bone and tooth mineralization, but also for regulating intracellular events in most, if not all, body tissues. For women aged 19 to 50, the Recommended Daily Allowances (RDAs) for Ca are 1,000 mg per day; for women aged 51 and up, it is 1,200 mg per day. The RDA for pregnant and lactating women is 1,000 mg. The RDA for men aged 19 to 70 is 1,000 mg; for men aged 71 and up, it is 1,200 mg (Food and Drug Administration, HHS, 2008).

Mg is the second-most prevalent cation in body cells after K and the fourth-most abundant element in the human body (Fiorentini et al., 2021). Mg participates in a variety of critical physiological functions, such as signal transduction, cell proliferation, DNA replication, and repair, K and Ca ion transport, and intermediate metabolism (Blaszczyk and Duda-Chodak, 2013). For people aged 19 to 51, the RDA is 400 to 420 mg for men and 310 to 320 mg for women daily. Pregnancy necessitates 350-360 mg per day, while lactation necessitates 310-320 mg per day (NIH, 2019).

Food is distinguished by varying mineral content, which is related to the type of raw materials used in food production, as well as the conditions of obtaining and processing such raw materials. For many people living in cities and suburbs who have less time for eating freshly prepared food, canned, jarred, and packaged foods provide an accessible and affordable source of nutrition (Comerford, 2015). Despite the high amount of minerals such as Na, K, Ca, and Mg that may be expected from these canned, jarred, and packaged foods, especially by Nigerian consumers; there is a scarcity of information on the nutritional contribution of these foods to the diet. Therefore, the purpose of this study was to find if these canned, jarred, and packaged foods are a good source of Na, Ca, Mg, and K in Nigerian diets, and to compare the mineral content to national and international nutrient composition databases.

Materials and methods

Sample collection

Totally, 188 canned, packaged, and jarred foods were purchased from malls, local markets, and street vendors in Owerri, Imo State in 2022. The samples were included cereals and cereal products (n=78), beverages (n=24), fish and fish products (n=10), fruits and vegetables (n=14), fats and oils (n=14), legumes, nuts, and seeds (n=16), meats and meat products (n=8), and milk and milk products (n=24). The name of the product, the production company, the expiry date, and the ingredients listed were all documented.

Sample digestion

Solid/semi solid samples were ground and also homogenised using a porcelain mortar and pestle prior to digestion. A microwave digestion system, multiwave 3,000 (Anton-Paar, Courtaboeuf, France) with a rotor for eight type X sample vessels was used to digest the samples (80 ml quartz tubes, operating pressure 80 bars). Prior to use, quartz vessels were decontaminated in a 10% Nitric Acid (HNO_3) (67% v/v) bath, rinsed with ultrapure water, and dried in a 400 °C oven. Dietary samples (50 ml for liquid samples and 1 g for solid/semi solid samples) were then measured and collected in a quartz digestion vessel before being wet-oxidized in a microwave digestion system with 3 ml of ultrapure water and 3 ml of ultrapure HNO_3 (67% v/v). One randomly chosen vessel was filled with reagents only and used as a blank throughout the process. Following filtration with a glass funnel and filter paper, sample solutions were quantitatively transferred into 50 ml polyethylene flasks after cooling at room temperature. After that, 5 ml of lanthanum chloride solution (27 g/L; Spectrum chemicals, USA) was added to each flask to prevent phosphate interference and element ionisation in the Flame Atomic Absorption Spectrometer (FAAS) flame (AA-6,650F Atomic Spectrometer, Shimadzu, Europa, Germany) (Chekri et al., 2012). Before analysis, the digested samples were filled with ultrapure water to the final volume.

FAAS determination procedure

-Instrumentation

Micro-sampling FAAS measurements were carried out on an AA-6,650F atomic spectrometer equipped with a Deuterium (D2) background correction system (used for the Mg analysis) and an oxidising air-acetylene flame, which was combined with an ASC-6,100 auto-sampler, allowing the use of the micro-sampling flame method and automatic sample dilution.

-Calibration

External calibration was used, and six standard solutions, including the calibration blank, were prepared using weighted linear regression at levels ranging from 0 to 5 mg Ca/L, 0 to 1 mg Mg/L, and 0 to 2 mg/L for Na and K. To maintain the same conditions for the samples, lanthanum chloride solution was added to achieve a final concentration of 10% (v/v).

-Optimization and sample analysis

The sample solutions were atomized in the spectrometer's air-acetylene flame after being ground into a spray in the nebulizer. As a radiation source, single-element hollow analyte cathode lamps were used. The operating parameters were set in accordance with the manufacturer's recommendations. With wavelengths of 422.7, 285.2, 589.6, and 766.5 nm, respectively, the spectrometer and flame conditions were tuned to give the best precision and sensitivity, maximize absorbance signals, and minimize backgrounds for the detection of Ca, Mg, Na, and K.

Statistical analysis

Ordinary statistical methods were used to compute the arithmetic mean, standard deviation, median, minimum (min), maximum (max) levels, 25^{th} and 75^{th} percentiles, and the number (n) of samples from general food groups and product groups. A box plot and whiskers were used to depict the distinction of micronutrient concentrations in food groups. On the corresponding figures, all product group results were expressed as mean±standard deviation (error bars). All statistical analysis was done using the Statistical Package for Social Sciences, version 20 software (SPSS Inc., Chicago, USA). Values of $p<0.05$ were considered to indicate statistical significance.

Results

Figure 1 and Table 1 show the distribution of the mean Na content of the 188 canned, jarred, and packaged foods commonly consumed in South-East Nigeria. Meat and meat products had higher levels of Na (0.623 g/100 g) when compared to other food groups followed by fish and fish products (0.524 g/100 g), as well as greater variability in the mean levels of Na per 100 g. In the food groups, nearly 75% of the meat and meat products had a Na content exceeding 0.68 g/100 g while some of them reached almost 0.69 g/100 g. In the fish and fish products group, the medium Na content (g/100 g) reached almost 0.52 (0.58-0.46). Overall, Na content (g/100 g) in other food groups (cereal and cereal products group, alcoholic and alcoholic beverages group, fruits and vegetable group, fats and oils group, legumes, nuts and seeds group, milk and milk products group) ranged between 0.40-0.49 g/100 g.

The K content of the 188 canned, jarred, and packaged foods commonly consumed in South-East Nigeria is presented in Figure 2 and Table 1. The beverages (alcoholic and non-alcoholic) food group and legumes, nuts, and seeds food group were found to have higher K content, 0.791 and 0.769 g/100 g, respectively. Overall, K content (g/100 g) in other food groups (cereal and cereal products food group, fish and fish products food group, meat and meat products food group, fruits and vegetables food group, fats and oils food group, and milk and milk products food group) ranged between 0.791-0.480 g/100 g. As illustrated in Figure 3 and Table 2, the levels of Ca in the food groups analysed. The Ca levels in the food groups analysed ranged from 0.442 to 7.827 g/100 g with the milk and milk products group having the

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highest concentration of Ca (7.827 g/100 g) and the meat and meat products group with the least concentration (0.442 g/100 g). Overall, Mg content (g/100 g) in all the food groups ranged between 0.354-2.020 g/100 g (Figure 4 and Table 2).

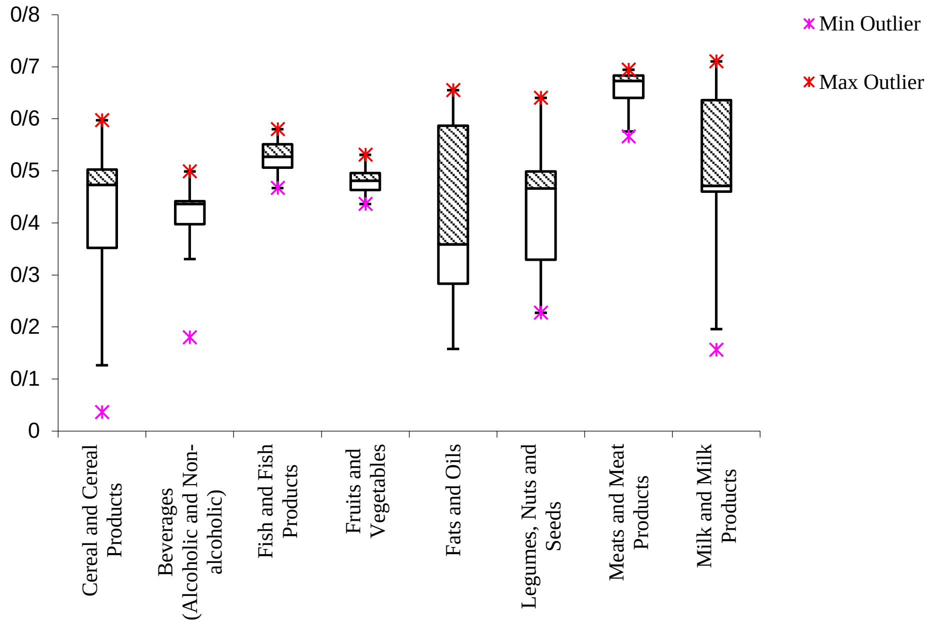

Figure 1: Boxplot showing the levels of sodium (Na) (g/100 g) in the food groups

Table 1: Levels of sodium (Na) and potassium (K), in retail samples of some foods (middle bound values in g/100 g fresh weight)

Na								
Food group	Cereals and cereal products	Beverages (alcoholic and non-alcoholic)	Fish and fish products	Fruits and vegetables	Fats and oils	Legumes, nuts and seeds	Meats and meat products	Milk and milk products
(N)	78	24	10	14	14	16	8	24
Mean	$0.420^{a,b,c}$	$0.407^{d,e,f,g}$	$0.526^{h,i,j}$	$0.480^{a,d,k,l,m}$	$0.415^{b,e,h,k,n}$	$0.442^{f,i,l}$	$0.651^{n,o}$	$0.491^{c,g,j,m,o}$
SD	0.118	0.082	0.043	0.032	0.199	0.128	0.058	0.178
Max-value	0.597	0.499	0.580	0.531	0.655	0.640	0.694	0.710
Min-value	0.035	0.180	0.467	0.436	0.158	0.227	0.566	0.156
Median	0.473	0.436	0.527	0.481	0.359	0.466	0.672	0.471
25th percentile	0.352	0.397	0.506	0.463	0.283	0.329	0.640	0.460
75th percentile	0.502	0.442	0.551	0.495	0.586	0.499	0.683	0.636
K								
Food group	Cereals and cereal products	Beverages (alcoholic and non-alcoholic)	Fish and fish products	Fruits and vegetables	Fats and oils	Legumes, nuts and seeds	Meats and meat products	Milk and milk products
(N)	78	24	10	14	14	16	8	24
Mean	$0.497^{a,b}$	$0.791^{c,d,e}$	$0.653^{f,g,h}$	$0.548^{c,d,i}$	$0.562^{d,g,j,k}$	$0.769^{a,i,j,l}$	$0.480^{k,m}$	$0.677^{b,e,h,l,m}$
SD	0.160	0.106	0.080	0.213	0.239	0.082	0.079	0.267
Max-value	0.882	0.871	0.730	0.762	0.854	0.873	0.545	0.925
Min-value	0.142	0.493	0.563	0.131	0.303	0.665	0.379	0.102
Median	0.501	0.834	0.692	0.566	0.458	0.775	0.499	0.765
25th percentile	0.395	0.791	0.570	0.508	0.378	0.677	0.436	0.672
75th percentile	0.612	0.834	0.711	0.682	0.783	0.833	0.543	0.817

N=Number of samples; Mean values with the same superscript letters are significantly different at p<0.05.

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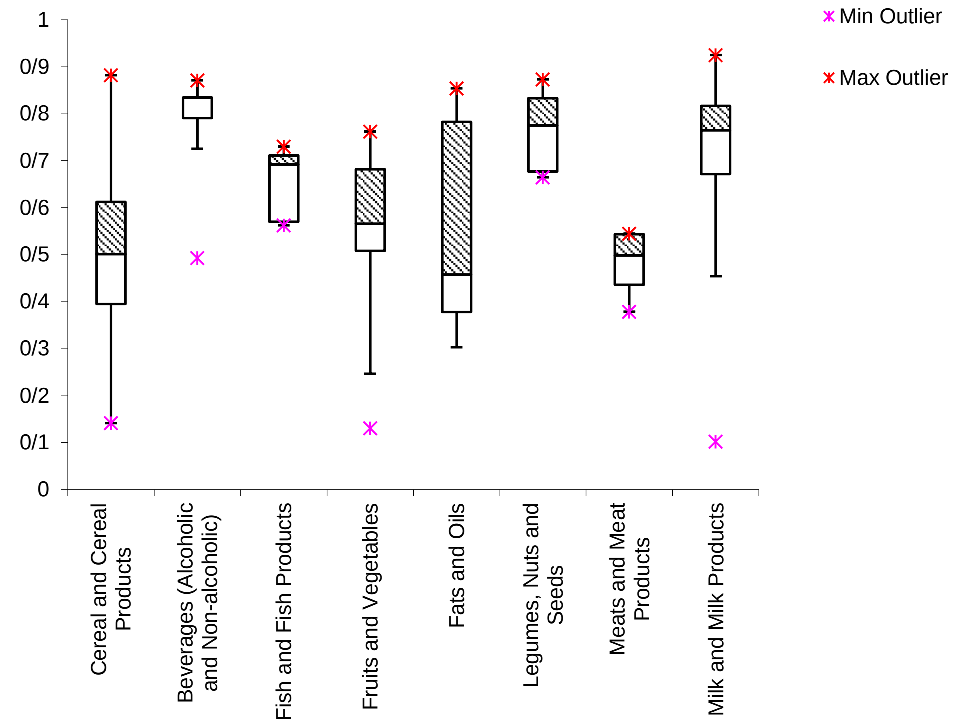

Figure 2: Box plot showing the levels of potassium (k) (g/100 g) in the food groups

Table 2: Levels of calcium (Ca) and magnesium (Mg) in retail samples of some foods (middle bound values in g/100 g fresh weight)

Ca Food group	Cereals and cereal products	Beverages (alcoholic and non-alcoholic)	Fish and fish products	Fruits and vegetables	Fats and oils	Legumes, nuts and seeds	Meats and meat products	Milk and milk products
(N)	78	24	10	14	14	16	8	24
Mean	1.523 ^{a,b,c,d,e,f}	1.905 ^{a,g,h,i}	2.868 ^{b,j,k,l}	2.020 ^{c,m,n,o}	1.234 ^{d,j,p,q}	0.964 ^{e,g,k,m,r}	0.442 ^{h,l,n,p,s}	7.827 ^{i,o,q,r,s}
SD	2.444	1.325	2.083	1.004	0.877	0.525	0.241	3.131
Max-value	10.800	4.250	5.980	3.730	3.040	1.790	0.694	11.50
Min-value	0.110	0.302	1.200	1.020	0.228	0.352	0.119	1.643
Median	0.686	1.600	1.930	1.490	1.011	1.040	0.478	6.700
25th percentile	0.271	0.978	1.220	1.470	0.867	0.420	0.350	5.600
75th percentile	1.300	2.500	4.010	2.480	1.315	1.170	0.570	11.00
Mg								
Food group	Cereals and cereal products	Beverages (alcoholic and non-alcoholic)	Fish and fish products	Fruits and vegetables	Fats and oils	Legumes, nuts and seeds	Meats and meat products	Milk and milk products
(N)	78	24	10	14	14	16	8	24
Mean	1.027 ^{a,b,c,d}	1.542 ^{a,e,f,g}	1.340 ^{e,h,i,j,k}	1.455 ^{b,f,h,l}	0.354 ^{c,i,l,m}	1.353 ^{g,m,n}	1.145 ^{j}	2.020 ^{d,k,n}
SD	0.136	0.488	0.068	0.228	0.489	0.151	0.227	0.440
Max-value	1.500	2.130	1.400	1.860	1.390	1.710	1.320	2.490
Min-value	0.749	0.568	1.260	1.190	0.006	1.170	0.833	1.480
Median	1.020	1.730	1.380	1.420	0.136	1.340	1.215	2.190
25th percentile	0.958	1.410	1.270	1.300	0.069	1.300	1.048	1.510
75th percentile	1.109	1.810	1.390	1.560	0.405	1.380	1.312	2.430

N=Number of samples; Mean values with the same superscript letters are significantly different at $p<0.05$.

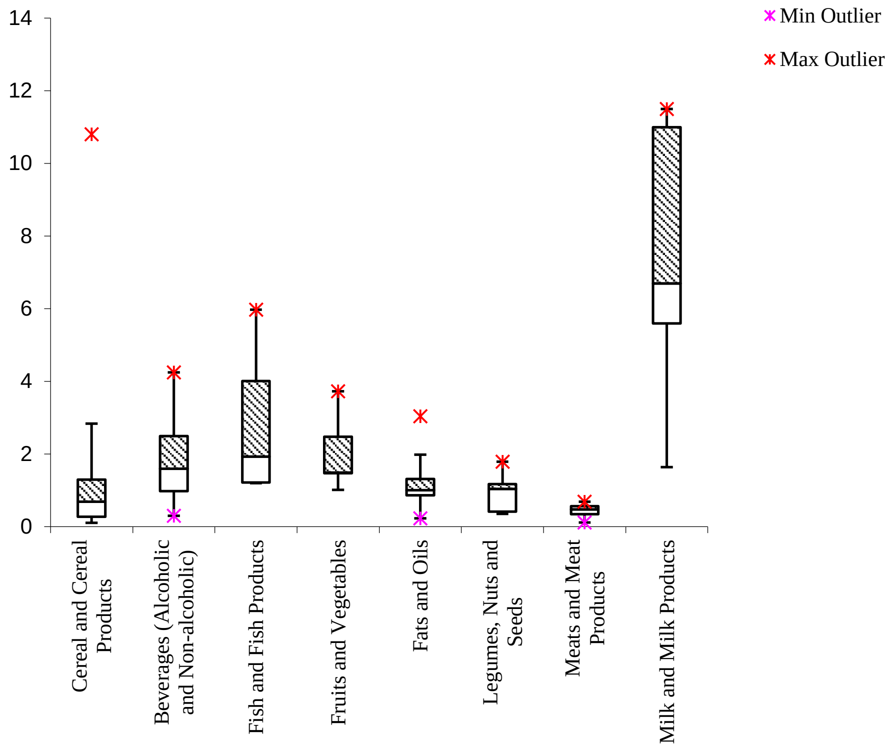

Figure 3: Box plot showing the levels of calcium (Ca) (g/100 g) in the food groups

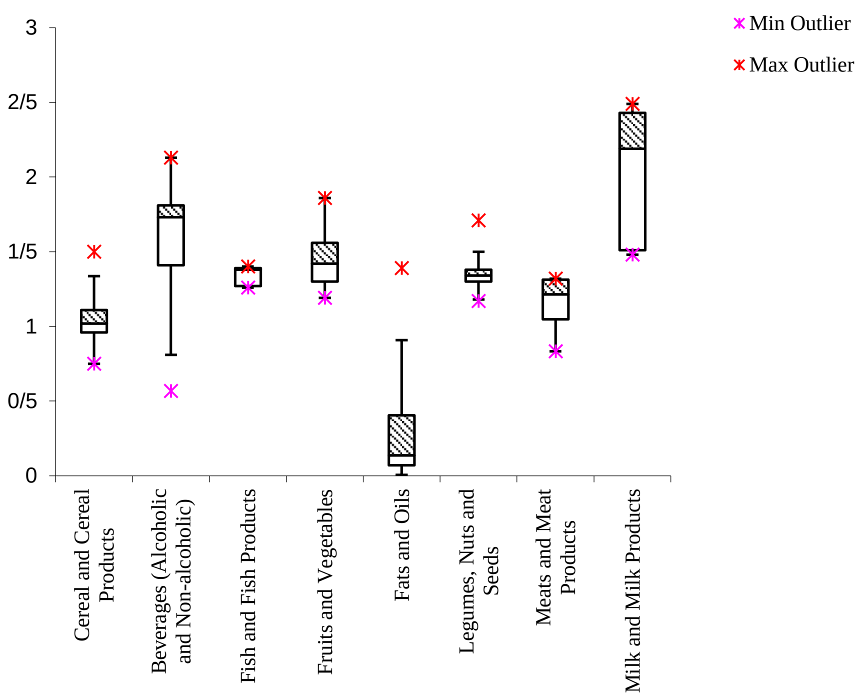

Figure 4: Box plot showing the levels of magnesium (Mg) (g/100 g) in the food groups

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Table 3: Instrumental parameters for Flame Atomic Absorption Spectrometer (FAAS) (Chekri et al., 2012)

Operating conditions	
Atomizer/gas flow rate (L/min)	
Fuel gas flow rate (L/min)	2
Support gas flow rate (L/min)	15
Flame type	Air-C_2H_2
Burner height (mm)	7
Measurement parameters	
Signal processing	Peak height
Sampling time (s)	40
Total acquisition time without dilution (s)	198
Autosampler parameters	
Sample volume	400 µl
Injection volume	100 µl
Injection speed	25 µl/s
Intake speed	130 µl/s
Discharge speed	150 µl/s
Optics Parameters	
Calcium (Ca)	
Lamp current low	10 mA
Wavelength	285.2 nm
Slit width	0.7 nm
Lamp mode	NON-BGC [a]
Magnesium (Mg)	
Lamp current low	8 mA
Wavelength	285.2 nm
Slit width	0.7 nm
Lamp mode	BGC-D2 [b]
Sodium (Na)	
Lamp current low	12 mA
Wavelength	589.2 nm
Slit width	0.2 nm
Lamp mode	NON-BGC
Potassium (K)	
Lamp current low	10 mA
Wavelength	766.5 nm
Slit width	0.7 nm
Lamp mode	NON-BGC

[a] NON-BGC=No Background Correction.
[b] BGC-D2=Deuterium Background Correction.

Discussion

High Na intake has been linked to the development of high blood pressure and arterial wall stiffening, making it a risk factor for coronary heart disease, oedema, or water retention (Anderson et al., 2015). Food processing may increase Na content in food products not only by adding salt (sodium chloride), but also by including additives containing this mineral in their formulation, which aims to modify properties such as texture and flavour while also extending shelf-life (Uthman-Akinhanmi et al., 2020). The result of Na level in our study for cereal and cereal products (0.035-0.597 g/100 g) is similar to those reported in Poland by Winiarska-Mieczan et al. (2019) for cereal products (3.042±3.4 g/kg) and in Spain by Orzáez Villanueva et al. (2000) for breakfast cereals (17.5-247.6 mg/100 g). However, according to a previous study by Nwanguma and Okorie (2013), the average Na content of a typical cereal product in Nigeria, such as bread, was 1.8 g/100 g. In our study, the highest concentration of Na was found in meat and meat products, followed by fish and fish products. The result of Na level in our study for meat and meat products (0.566-0.694 g/100 g) is lower than those reported in Serbia by Jankovic et al. (2019) for meat and meat products (11.8 g/kg) but similar to those reported by Sparks et al. (2018) for meat and meat products (775 mg/100 g). According to Song et al. (2021), processed meat and fish products from China had the highest Na levels (1,050 mg/100 g), followed by those from the United States, South Africa, and Australia, with the lowest levels being found in the United Kingdom (432 mg/100 g). The researchers came to the conclusion that the Na level of processed meat and fish products varies significantly between nations and between food subcategories. This suggested that there was a lot of

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space for food manufacturers to reduce the Na level of their products and for customers to choose less-salty foods. Beverages (both alcoholic and non-alcoholic) had the lowest Na concentration. The Na concentration in the alcoholic and non-alcoholic beverages in our study is similar to that reported by Ajala et al. (2019) for non-alcoholic beverages in Nigeria (169.04±7.04-585.78±6.76 mg/kg). Prasad (2018) also reported a low concentration of Na in beer (1-14 mg/100 ml) in Fiji. This could be as a result of increased effort towards reduction in Na content of beverages worldwide (Cradock et al., 2022). In 2010, the global average Na intake was around 4,000 mg/day, which was more than double the WHO's maximum recommendation of 2,000 mg/kg (Powles et al., 2013). Song et al. (2021) had reported the mean Na concentration in meat and fish products 1,050 mg/100 g in china, and 432 mg/100 g in the UK. According to a previous study conducted in China in 2013, processed meat and fish products typically had 1,029 and 1,424 mg of Na per 100 g, respectively, which is more than half of the daily recommended amount (Huang et al., 2016). In developing countries such as China, Na intake is primarily from cooking; however, with rapid urbanisation and dietary transition, consumption of hidden Na in processed foods such as meat and fish is rapidly increasing (Farrand et al., 2017). It was estimated that Na intake from meat and meat products provided between 16 and 25% of daily Na intake in developed countries, where processed foods account for more than three quarters of salt intake (Downs et al., 2015). Many nations have worked to lower processed food's salt level. Various kinds of processed food have voluntary salt reduction targets established by the UK, the USA, and Australia (Song et al., 2021). The Na concentrations in the various food groups studied in this study were all lower than the national and international reference values for this micronutrient as stated by the United States Food and Drug Administration (FDA) (USDA, 2019), European Food Safety Authority (EFSA, 2017), and FAO/WHO (Lewis, 2019).

K is involved in blood pressure regulation and stroke prevention, as well as bone Ca storage and kidney function (Palmer and Clegg, 2016). The beverages (alcoholic and non-alcoholic) group had the highest K value in the current study, followed by legumes, nuts, and seeds. K is widely distributed in the food groups, so with a few exceptions for cereals and cereal products, and meats and meat products, most of the food groups considered in this study provided high amounts of K. K levels ranged from 0.791 g/100 g in beverages (alcoholic and non-alcoholic) to 0.480 g/100 g in meat and meat products. Ajala et al. (2019) had reported a higher concentration of K (105.11±9.99-112.070±8.36 mg/kg) in certain non-alcoholic beverages produced in Nigeria. Styburski et al. (2018) also had reported variations in the K content of a popular low alcoholic drink consumed across some European and Asian countries with range between 0.06-0.191 g/L. Although it has been noted elsewhere that alcoholic beverages are poor sources of K, if we compare the findings of our studies with those of other researchers, it must be noted that different types of beer exhibit notable variations in mineral content due to the type of water used, the resources used to produce the beverage, the type of yeast used, and the technological processes used during production (Styburski et al., 2018). Dietary K is beneficial both on its own and through its effects on the body's Na management. Diets high in K and low in Na may lower the risk of high blood pressure and stroke. Our study found that all of the food groups studied had higher K content than Na content, with the exception of meat and meat products, which had higher Na content than K content. Low K intake is linked to an increased risk of hypertension, arthritis, cancer, stroke, infertility, and gastrointestinal disorders (Tunsaringkarn et al., 2013). The K levels in the various food groups in our study were higher than the United States FDA and control reference value (USDA, 2019) but lower than the EFSA reference value (EFSA, 2017).

When compared to other elements, Ca is the most prevalent in the body and is primarily found (99%) in hard tissues. It is well-known that Ca absorption from meals is influenced by a variety of factors. Fibre and caffeine inhibit absorption, whereas lactose, certain amino acids, and vitamin D promote it (Abrams et al., 2002; Bosscher et al., 2003; Heaney, 2002; Holick et al., 2011). Adults may develop osteomalacia and osteoporosis if their diets are inadequate in Ca (Kim et al., 2014; Saghafi et al., 2013). Due to the activity of Parathormone (PTH), the drop in blood Ca concentration causes Ca deposits, which were initially stored in bones, to be mobilized (Saghafi et al., 2013). The excess of this element in physiological settings is primarily deposited in bones, hence occurrences of hypercalcaemia are quite rare (Mirrakhimov, 2015; Peacock, 2010). Principal hyperparathyroidism and malignancies are the primary causes of hypercalcaemia, both of which can result in tissue diseases and the aminodeposition of Ca salts in other tissues (Mirrakhimov, 2015). According to the findings of our investigation, the milk and milk product diet group had the highest Ca concentration. This is in line with earlier research by Babaali et al. (2020), who found that milk and milk products had the highest concentration of Ca among examined the food items. They attributed this to the concentration effect of milk coagulation and dehydration during the production of some milk and milk products, such as cheese. However, Lawal et al. (2015) has reported a slightly lower

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concentration of Ca (12,183.16 mg/kg) in powdered milk consumed in Nigeria. After reviewing the findings of all diet research carried out globally, Babaali et al. (2020) observed significant differences in the Ca content of several dietary items. The amount of Ca in plant meals relies on the Ca content of the soil and the rate of Ca absorption. Additionally, technical advancements and cooking techniques may alter the amount of Ca in these foods (Jodral-Segado et al., 2003). Breed, genetic variation within a breed, health circumstances, the environment, and management practices are among factors that might impact the amount of Ca in cow milk. The differences may also be attributed to the fortification of powdered milk with trace elements that is mostly practiced by the manufacturers. The national reference standard as stated by National Agency for Food and Drug Administration and Control (NAFDAC) (NAFDAC, 2019) for such micronutrients was virtually met by the mean Ca content in milk and milk products, which was reported to be 0.782-0.313 g/100 g. The Ca concentrations in the various food categories from the current study were all below the international reference value for such micronutrients as stated by the United States FDA (USDA, 2019), EFSA (EFSA, 2017), and FAO/WHO (Lewis, 2019).

Numerous important biological functions depend heavily on Mg. Although the concentration was below the national and international standard values for Mg in food, the results of the current investigation show that the milk and milk product group has the highest concentration of the micronutrient Mg. Due to manufacturers' widespread practice of fortifying milk and milk-derived goods with the micronutrient, milk and milk-derived products have a high level of Mg (Lawal et al., 2015). In a study by Lawal et al. (2015) on the assessment of mineral elements in different brands of powdered milk sold in Zaria, Nigeria, the mean Mg content was found to be 986.70 mg/kg. According to earlier research (Capar and Cunningham, 2000), nuts and oil seeds, as well as the food group of fruits and vegetables, contained the highest mean levels of Mg. This is likely because some nut varieties, like cashew nuts or peanuts, have been known to contain higher Mg contents (Chekri et al., 2012). Due to the inadequate amount of Mg in the other food groups analysed in our study such as cereals and cereal products, beverages, fish and fish products, fruits and vegetables, fats and oils, meat and meat products as well as milk and milk products, Mg needs to be supplemented because the typical diet does not adequately meet these demands (Szajnar et al., 2019).

Conclusion

We conclude that some efforts are necessary to improve the nutritional quality of canned, jarred, and packaged foods distributed in Nigeria. Given the increased acceptance of these processed foods by the general public, the food processing and packaging industries in Nigeria should be committed to food fortification and supplementation as a way to increase the micronutrient content of their products. Regulatory organizations like the Standard Organization of Nigeria (SON) and NAFDAC should continue to monitor and support efforts at fortifying foods with additional nutrients.

Author contributions

R.C.E. investigation, writing-reviews, editing, visualisation, writing-original draft, conceptualization, and resources; C.C.N. supervision, methodology, visualization, project administration; S.O.A. formal analysis, and validation. All authors read and approved the final manuscript.

Conflicts of interest

The authors claim to have no conflicting interests.

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