

Evaluation and Analysis of Dietary Essential Mineral Micronutrients in Selected Malaysian Foods Using FAAS and ICP-MS

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Abstract

Food source could provide essential mineral elements necessary for preventing and remedying the cases of Mineral Deficiency Diseases (MDD). This source is cost effective, safe, affordable and accessible. In this study, essential elements: Ca, Mg, P, K, Na, Cu, Fe, Mn, Se and Zn were determined in 126 food samples eaten in Johor Bahru, Malaysia. The all-serving-units-inclusive food samples were oven-dried until constant weight, homogenized and wet digested serially with nitric acid and hydrogen peroxide mixture. The major and minor elements were respectively determined by FAAS and ICP-MS. The elements showed presence in all foods. The food element/RDA percentage ratios of (Ca: 50.0; P: 322.8) and (Mn: 10.5; P: 177.5) were obtained respectively relative to maximum and minimum Recommended Dietary Allowance (RDA). The study has proven that the foods could be viable source of the elements choosing appropriate foods. These essential elements containing foods can be exploited for health maintenance, remedy and even cure for MDD.

Keywords: food, all-serving-units-inclusive, mineral deficiency disease (MDD), supplementation, remedy, mineral elements, FAAS, ICP-MS

1. Introduction

Foods are substances that are of chemical in nature with nutritive and nourishment importance. Researches on food are therefore expected to show that a given food could provide nourishment to the body, qualitatively, quantitatively and affordably. The current challenge is to create a nutritional awareness of qualitative, affordable and available foods that can be sourced locally.

Foods basically, contain macronutrients and micronutrients. The mineral micronutrient content of food is the focus of this study. The mineral micronutrients are the inorganic chemical elements contained in foods and which are needed to assist in various body functions, particularly, to regulate body fluids and main body interaction. Mineral elements are essentially needed in substantial quantities (major elements) and minute or smaller quantities (trace elements). Mineral elements work hand in hand with other food micronutrient classes like vitamins as co-factors and also promote the functioning of the macronutrients like carbohydrate, fats and protein.

The essentiality of these mineral elements as asserted by Pauling Linus, father of orthomolecular medicine and a two-time Nobel prize winner in Chemistry and Peace (Linus Pauling, 1982; Linus Pauling, 1986) can be noticed in terms of the harm caused by low or non-presence of these elements (FAO/WHO, 2004; WHO/FAO, 2004). Priority elements (iodine, iron and zinc) were listed in addition to earlier selected elements (Selenium, Copper, Calcium and Magnesium) in various joint WHO/FAO reports (FAO/WHO, 2004; WHO, 1996; WHO/UNU/UNICEF, 2001; Yip, 2001). Sourcing these essential elements through supplementation, could serve need for which is intended. However, supplementation sometimes leaves some adverse effects and toxicities on non-tolerating individuals as well as when in excess. There is therefore urgent need to consider the potential of the normally and locally eaten foods to supply these essential elements and hence confront the mineral deficiency diseases (MDD). Foods as a source, are natural, less complicated, accessible and cheaper, needs no

expertise and above all, meet the conditions of green health concept.

Malaysia, like elsewhere in the world, have food varieties influenced by culture and agricultural practices. This influence is as varied as nationality segment of the country. Thus, we have foods which originate from Malays, Indians, Chinese, Nyonya etc. Rice appears to be the staple food in Malaysia as in most countries in the region. For instance, *nasi lemak*, a rice and coconut milk based dish commonly called the national dish. Majority of the foods are rice derivatives. Other foods of are noodles, bread, meat, poultry, beef, mutton, sea foods, vegetables and fruits. Popular fruits include durian, *rambutan*, mangosteen, lychee and *longan*.

Analysis of food for information about its mineral content is not new. However, there is scanty data in the literature that focus on all-serving-units-inclusive food analysis. This is the analysis of food as are traditionally eaten in combined and ready-to-eat forms. This is the form in which anyone in the restaurant or at home eats them. Most literature data on foods focus individually isolated foodstuff in either cooked, raw or both forms. These data would not adequately represent actual mineral intake of eaters as it omits the fact that foods are traditionally eaten in combined forms and served along with other food units. This traditional food preparation is often the basis for their local names. A Malaysian is able to distinguish *nasi lemak* from *nasi kerabu* based on the method and the ingredients combined and served along in them despite the fact that they both have rice in common.

Mineral malnutrition is said to account for 11 per cent of the global burden of disease. It is the number one risk to health worldwide (Lancet, 2008). Countries may lose an estimated 2 -3 per cent of their Gross Domestic Product (GDP) as a result of iron, iodine, and zinc deficiencies (WHO, 1996).

In Malaysia, there have been some reported cases of anaemia. This is a disease associated with iron deficiencies (Sagin, Ismail, Mohamd, Pang, & Sya, 2002), observed high prevalence of anaemia among men greater than 40 years, adolescents, young women and elderly women greater than 61 years in the remote interior communities in Sarawak. In another study on adolescents, in the Sabah rural community, 20% of the subjects were found to be anaemic (Foo, Khor, Tee, & Prabakaran, 2004). It was also reported (Norhaizan & Faizadatul, 2009) that the iron deficiency cases, was nearly one million.

Osteoporosis (weak bones) cases are mineral deficiency diseases linked with poor intake of calcium, phosphorus and magnesium were also reported in Malaysia. Hip fractures as a result of osteoporosis were said to have affected 218 women and 88 men per 100,000 (Lai, Chua, Chan, & Low, 2008). In a study (Lau, Lee, & Suriwongpaisal, 2001), osteoporosis that was prevalent among the elderly was characterised by weak and easily fractured bones of the spine, hip, wrists and arms especially in the aged population. Furthermore, as at 2009, over 2 million cases were reported in Malaysia (Norhaizan & Faizadatul, 2009).

The objective of this paper is to quantify essential major elements (Ca, Mg, P, Na and K) and essential trace elements (Cu, Fe, Mn, Se and Zn) in served food dishes and also to evaluate these elements sourcing capacity of the foods. The goal is therefore to show that some of the commonly eaten foods are able to supply the essential elements enough to discourage the use or administration of mineral supplements.

2. Materials and Method

2.1 Samples and Sampling

126 food samples containing 41 food types eaten in Skudai-Johor Bahru area of Malaysia were selected for this study. The food types cut across the Malaysian Malay and Indian foods common in Skudai, Johor, Malaysia. The food dish samples listed in Table 1, were obtained in triplicates from popular restaurants in the Johor Bahru campus of Universiti Teknologi Malaysia.

Table 1. The selected Malaysian food samples

1	Apam Balik	12	Ikan Pari Bakar	23	Nasi Berlauk	33	Roti Jala with Chicken curry
2	Ayam Goreng Kunyit	13	Kampung Belacan	24	Nasi Goreng Kampung	34	Roti Naan (with soup)
3	Ayam Percik	14	Keropok Lekor	25	Nasi Kerabu	35	Sambal sotong
4	Banana leaf Rice	15	Ketupat	26	Nasi Lemak	36	Sambar
5	Beef Rendang no Nasi	16	Kuih Talam	27	Nasi Paprik	37	Sayur Lodeh
6	Beef Rendang with Nasi	17	Maggi Goreng	28	Onde-Onde	38	Serunding
7	Chapati Kima	18	Mamak Rojak	29	Pongal	39	Soto Nasi

8	Cilli ketchup Black	19	Mee Robus	30	Pulut Inti	40	Teh Tarik
9	Fish Head Curry	20	Mi Hun Soto	31	Rasam	41	Thosai
10	Idli	21	Murtabak	32	Roti Canai		
11	Ikan Asam pedas	22	Nasi Beriani	32	Nasi Beriani		

The foods were purchased from the local restaurants. This pattern of purchase is to preserve their local identities and traditional values. Information about food types and their component ingredients were obtained from major food websites and some experienced restaurants operatives to model a standard benchmark. The standardised food model chart for description and ingredients was cross-matched with the selected restaurant recipe. Necessary recipe adjustments were made thereafter.

2.2 Treatment and Handling of Samples

Three samples of each food type were obtained in triplicates from popular restaurants in Johor Bahru campus of Universiti Teknologi Malaysia and taken to the laboratory. The sampled *all-serving-units-inclusive* foods are the ready-to-eat and adult-size dishes, cooked and served by the restaurants. The samples were collected in transparent polyethylene containers (for the foods) and leak proof nylon bags (for soups). The fresh samples of *all-serving-units-inclusive* foods were thoroughly homogenised in a 1.5 litre capacity ceramics mortar with their pestles.

The crucibles were top covered with perforated aluminium foils and then transferred to oven (memmert™, Beschickung-loading model100-800). The temperature was set to 100-110°C for up to 48 hours after constant dried weights were obtained. The covering foils were perforated (about 3mm diameter), in order to allow easy escape of steam and also to avoid aerial cross-contamination of the samples. The triplicate dried samples of each food types are homogenized to powder form using Philips^R blender (Model HR2000) chosen because of its stainless blade cutters, transparent plastic material as food chamber (1.5L) and the detachability of all its parts for easy washing.

2.3 Ashing and Dissolution of Samples

Wet ashing procedure with the mixture of Nitric acid and Hydrogen peroxide was used as illustrated in **Table 2**. 1g of aliquot of each of the previously homogenized dry sample blends were accurately weighed into 100 mL conical flasks using Ohaus™ analytical balance (precision standard, model TS400S). 10 mL of nitric acid was added to soak the sample overnight. The conical flasks were then covered with polymer membrane and put in the fume cupboard. Concentrated acid HNO₃ (65 %,) and hydrogen peroxide H₂O₂ (40%) both of high purity, Grade AR QrēC™ laboratory preparation, New Zealand). De-ionized water (Milli-DI™, Millipore) was used. The 100mL capacity conical flasks on which an inverted glass funnel was put were mounted on the hot plate/ stirrer electrical appliances (Lab companion hotplate stirrer, model HP300, made in UK). The inverted funnel on the conical flask as well as and narrower neck of the flask were to allow gaseous bye product only to escape while other materials are returned. The optimum digestion procedure adopted is described in **Table 2**. The freshly dissolved and digested solutions appeared as colourless or light yellow/brown clear solutions. They were filtered with white filtered papers (ADVANTEC, qualitative filter papers, and 125 mm diameters) and then with syringe micro filter of 0.2 or 0.45 µm pore sizes in readiness for instrumental analysis.

Table 2. Adopted optimum wet ashing parameters and procedure

Steps	+ De-ionised H ₂ O (mL)	+Conc. HNO ₃ (mL)	+Conc. H ₂ O ₂ (mL)	Heat Control	Observation	Time (min.) /Termination point
1	Nil	10	Nil	Nil	Swollen, yellowish residue	Overnight
2	Nil	5	2	Low Medium	Yellow solution Blackish residue	20/ Nil 30/ till nearly dry
3	Nil	10	4	Medium	Dark viscous solution	30/ till nearly dry
4	30	5	2	Medium	Brownish solution	30/ till nearly dry
5	30	10	2	High	Brownish/ Yellowish solution	20 / till nearly ¼ of initial volume

2.4 Instrumental Determination

Flame Atomic Absorption Spectrometer FAAS (PerkinElmer AAnalyst 400 with WinLab 32 computer software) was used to determine Ca, Na, K, and Mg. The Inductively Coupled Plasma-Mass Spectrometry ICP-MS (PerkinElmer SCIEX ICP- Mass spectrometer, ELAN 610 with WinLab 32 computer software). It was used to determine Cu, Fe, Se, P, Mn and Zn. The optimum operating conditions of the instrument was set by fixing and observing some parameters as indicated in **Tables 3 and 4** respectively. Standard solutions were prepared to calibrate the instrument. Stock solutions of 1000 ppm (AAS) and 1000ppb (ICP-MS) containing elements of interest are the preparations of Perkin Elmer laboratory, USA, were used. The stock solutions were drawn by means of micropipette (Eppendorf Reference^R Variabel).

Table 3. Operating parameters for flame atomic absorption spectrometer

Parameters	Conditions	Parameters	Conditions
Hollow Cathode Lamp	4.0Ma	Nitrous oxide flow rate	4.7L min ⁻¹
Current			
Wavelength	Na(589nm),K(766nm)Ca(422.67nm), Mg(285.21 nm)	Aspiration rate	3.2mL min ⁻¹
Type of Flame	N ₂ O-C ₂ H ₂	Slit width	0.5nm
Temperature	≤ 2600 ⁰ C	Burner Height	13.5mm
Background Correction	Deuterium Lamp	Blank solution	De-ionized water (Milli-DI TM , Millipore)
Acetylene flow rate	4.2L min ⁻¹	Operating environment	25-30 ⁰ C

Table 4. Operating parameters of inductively coupled plasma-mass spectrometer

Operational modes conditions	Plasma mode conditions	Instrument mode conditions	Selected analytes' masses (m/v)
Replicates : 3	Radiofrequency generator: 40 MHz	Sample update rate : 1.0 mLmin ⁻¹	Cu : 63
Peak processing mode : Average	Plasma air flow rate : 15 Lmin ⁻¹	Sample read delay : 30s	Fe : 57
Signal profile processing mode : Average	Nebulizer air flow rate : 0.96 Lmin ⁻¹	Spray chamber : Cyclonic	Mn : 55
Detector mode : Dual	Auxiliary air flow rate : 1.05 Lmin ⁻¹	Interface : Pt cones	P : 31
Scanning mode : Peak hopping	Blank solution : De-ionized water (Milli-DI TM , Millipore)	Sample cone : Nickel, 1.00mm orifice diameter	Se : 82
Resolution : High		Blank solution : De-ionized water (Milli-DI TM , Millipore)	Zn : 64
Dead time : 35ns		Operating environment : 25-30 ⁰ C	
Dwell time : 100ms			
Integration time : 900ms			

2.5 Statistical Analysis

Specify Statistical Analysis. Statistical tools employed include the mean, standard deviation and range values, kurtosis and skewness were measured. This univariate analysis was performed by means of Excel spreadsheet statistical data analysis for windows.

3. Results and Discussions

3.1 Quality Assurance and Validation of Techniques

3.1.1 Digestion Optimization Procedure

Wet ashing procedure was adopted because of its flexibility in controlling extent of temperature as well as the ashing agents being used. Table 2 was the optimized procedure gave efficient digestion. Mixture of Nitric acid and Hydrogen peroxide was used as ashing agent. This combination has been proven to be of great efficiency (Luo et al., 2010). Additional advantage of the combination is that the oxidising action of HNO₃ is well pronounced far below the temperature of 120⁰C which is its boiling point. This moderate temperature gave

determination efficiency and safeguards the loss of some trace elements such as selenium, cadmium, lead, zinc, arsenic and nickel (Namik & Yavuz, 2006). The combination with hydrogen peroxide which is also an oxidizing agent was to contribute synergistic effect of oxidation on dissolution of the samples (Namik & Yavuz, 2006).

3.1.2 Efficiency, Precision and Accuracy of Instruments

Optimised FAAS based on adjusted method parameters has been shown by (Luo et al., 2010), to be of high reliability in detection of clinical human milk foods. Similarly, the study by (Avula, Wang, Smillie, Duzgoren-Aydin, & Khan, 2010), showed that improved ICP-MS method parameters also contributed to high accuracy and precision of results obtained when applied to botanical food materials. All the samples to run with the instruments were re-filtered with syringe micro filter of 0.2 or 0.45 μm pore sizes to ensure that samples were particles free. The mean, standard deviations and relative standard deviations results of the triplicate measurements were automatically computed and later printed. Efficiency of both the FAAS and ICP-MS instruments was checked with Quality Control Samples (QCS) method. While running the instruments, QCS was the 11th sample measured after every 10 determinations. This 11th sample is the repeat of any of the samples previously measured. This is to check if the value still remained the same or deviating from what was earlier recorded. The amount of change or deviation in terms of percentage deviations from previous recorded values was calculated. When greater than $\pm 5\%$ of previous records, then measurements were stopped. The operating conditions including standard solutions checked, reset and re-prepared.

Quality assurance steps were taken in line with recommended best practice for technique validation (NMLK, 1996). Parameters taken for validation of the analytical techniques for the determination of elements in food samples were: selectivity and specificity, precision, limit of detection (LOD) computed ($n=6$) and in line with IUPAC criteria, Limit of quantification (LOQ) and linearity. The precision was evaluated by measuring the repeatability of the method for all the elements. These evaluation were carried out using relative standard deviation (RSD) of repeated determinations (one sample was picked and determination was repeated 6 times). Intraday and within-laboratory variations were also evaluated. Intraday variation coefficients for one sample preparation in 6 replicate measurements of the same sample were in the acceptable range three elements randomly selected. Similarly, within-laboratory reproducibility, coefficient of variation 6 different sample Preparations measured on different days also did not exceed the 10% limit ($n=6$) for all analytes. All the correlation coefficient values obtained were greater than 0.995, which was considered good for instruments indicating acceptable consistencies. The accuracy of the methods used was validated by the certified reference materials SRM 1570a of elements in spinach leaves obtained from the National Institute of Standards and Technology (NIST). The recovery assay obtained as presented in Table 5 was satisfactory.

Table 5. Certified and measured values of elements determined in the certified reference materials SRM 1570a of elements in spinach leaves

Elements	Certified m \pm sd (mg/g)	Measured m \pm sd (mg/g)	Recovery (%)	LOD
				0.098 ^a
Ca	15.27 \pm 0.04	15.02 \pm 0.45	98.4	
Mg	8.90 \pm 0.00	8.62 \pm 0.38	96.8	0.025 ^a
P	5.18 \pm 0.01	5.05 \pm 0.41	97.5	0.235 ^b
K	29.03 \pm 0.05	28.42 \pm 2.72	97.9	0.033 ^a
Na	18.18 \pm 0.04	18.74 \pm 1.02	103.1	0.013 ^a
	12.20 \pm 0.60			
Cu		11.69 \pm 0.78	95.8	0.578 ^b
Mn	75.9 \pm 1.90	73.40 \pm 4.30	96.7	0.325 ^b
Se	0.117 \pm 0.01	0.110 \pm 0.01	94.0	0.388 ^b
Zn	82.00 \pm 3.00	83.80 \pm 4.31	102.2	0.012 ^b

m = mean, sd = standard deviation, a = mg/L, b = $\mu\text{g/L}$

3.2 Elements Content of the Studied Foods

Tables 6 gives the elements load of in the studied foods while Table 7 gives the summary of the concentration of the elements. The magnitude of the elements is substantial and close to what is universally expected of foods

capable of supplying adequate mineral nutrients. The concentrations of essential trace elements in the studied foods are comparable to some previously studied Malaysian foods (Norhaizan & Faizadatul, 2009; Siong, Chao, & Mizura, 1989; Zawiah & Rosmiza, 1995). 100g dish of Nasi lemak, in this study, contains Cu (0.10mg), Fe (1.89mg) and Zn (1.14mg). Similar study of Nasi lemak by Zawiah & Rosmiza (1995), reported Cu (0.10mg), Fe (1.25) and Zn (0.55 mg) as its element content. The slight difference may be accounted for on the basis of analytical treatment and materials analysed. The method of all-serving-units-inclusive food analysis was used. This method accounts for the difference in the results. It is an approach which analysed all that was served along with the Nasi lemak dish such as soup and hard-boiled egg. Same explanation can be given for the Nasi lemak content obtained by Zawiah & Rosmiza (1995), with the lower values obtained for Fe and Zn. The difference of values of essential elements in raw squids reported by Kwozcek, Szefer, Hac, & Grembecka (2006), can also be attributed to determination of included stuff like soup and curry served in the Malaysian food equivalent called Sambal sotong. Sambal sotong is a dish of squids cooked in chili based sauce as well as other stewed condiments.

The Ca:P molar ratio of average food is lower than the recommended healthy intake of 1, but not far from what was commonly obtained among western foods and the study case reported of Finnish women by Calvo & Park (1996) and Kemi et al. (2009). However, there are still some foods like Kuih talam and Rasam which are quite close the recommended values. Low calcium: phosphorus ratio in diets has effect on serum parathyroid, bone mineralisation and calcium metabolism (Kemi et al., 2009). Similarly, another index of looking at healthy food is K: Na ratio which is observable in the mineral distribution in the studied foods. The average food shows richer potassium than sodium. This can be attributed to abundance of fruits and vegetables content of some of the food dishes (Adrogué & Madias, 2000; Horacio J. Adrogué & Nicolaos E. Madias, 2007). The higher the K: Na ratio the richer is the food and the less risk of some heart related diseases (Horacio J. Adrogué & Nicolaos E. Madias, 2007). The trace elements also have moderate presence in average food as compared to reported foods in (Salau, Ali Deba, & Jimoh, 2012; Salau, Ali Deba, Usman, & Alagba, 2012).

Each of these elements has good presence in some handful of food samples. Calcium is prominent in Banana leaf rice dishes as well as those labelled 9, 12, 18 and 22. Roti canai contain magnesium in significant quantity as well as labelled dishes 4, 34, 35 and 41. Phosphorus has high quantity in Mee robus and others like dishes 4, 9, 22 and 23. Nasi kerabu is rich in Potassium as well as other foods such as 4, 9, 22 and 23. Sodium has good presence in Banana leaf rice and also in 6, 19, 22 and 24. Copper is of high value in Nasi beriani as well as foods like 4, 7, 23 and 32. Nasi paprika has high Iron content. Other food dishes with high iron content are 4, 22, 25 and 33. Manganese is prominent in Thosai as well as in 4, 22, 33 and 40. Sambal sotong has significant presence of Selenium. Selenium was also found substantial in 4, 8, 23 and 35. Zinc containing foods include Banana leaf rice as well as in dishes 23, 25, 35 and 4.

3.3 Descriptive Statistical Data of the Foods

The elements distributions, in Table 7, which were characterised at 95% confidence interval, showed moderately high and positive skewness values depicting non symmetrical, but tailed nature of the elements. The distribution was therefore tailed towards more positive values. The values of kurtosis were also high indicating a peaked clustered distribution relative to the normal distribution. The negative kurtosis value obtained in the case of potassium and iron. This implies that they exhibit flatness relative to the normal distribution. The range values are generally large suggesting extreme limits. This implies that element contents vary widely in the studied food. The overall statistical patterns revealed wide divergence of minerals across the sampled foods. This wide disparity further gives credence to the fact that the each food is unique in terms of its element content.

3.4 The Content of the Foods Compared with the Dietary Allowance

The food content data in Table 7 also includes dietary information. This information is based on the documented dietary intake allowances: Dietary Guidelines for American (2005) and Malaysian Dietary Guidelines (2010). These documented values are derived from and within the computed values of Recommended Nutrient Intake (RNI), Recommended Dietary Allowance (RDA), Acceptable Macronutrient Distribution Range (AMDR), Adequate Intake (AI) and Upper Limit (UL). The maximum range values of the elements in the studied foods when compared with dietary allowance showed that there are foods whose mineral contents can meet up with minimum mineral requirements. This is because the elements in those foods are more than 50% close to the allowed value. The value of about 50% implies that the containing foods only need to be at least repeated twice daily to meet up. However, if the maximal elements content in the studied food is computed relative to the maximum dietary allowance of the elements, daily manganese requirement cannot be met. The elements K, Ca and Mg in the studied food can sparsely meet up maximum requirement because such foods have to be eaten,

repeatedly in a day.

Table 6. Essential major element contents (mg) and trace elements contents (μg) per dried serving dishes

Code	mg per dried serving dish							ug per per serving dish		
	Ca	Mg	P	K	Na	Cu	Fe	Mn	Se	Zn
1	5	24	84	339	426	152	3757	433	1	1178
2	11	14	103	320	333	107	3857	105	4	628
3	41	6	119	88	108	41	1115	56	2	756
4	400	145	1023	1787	2144	741	12691	2212	30	7522
5	12	25	158	702	973	221	9054	291	17	3161
6	44	39	264	1356	1481	325	10000	591	10	4287
7	62	34	142	454	510	592	6596	487	5	2246
8	5	9	41	708	390	268	5355	13	26	1383
9	279	52	894	508	607	235	6241	486	24	2815
10	19	18	111	538	659	129	2427	1062	3	1509
11	20	16	184	630	301	121	2979	562	22	944
12	102	31	261	258	350	109	3175	434	18	1206
13	26	15	92	670	713	119	5536	230	5	1297
14	11	10	56	485	550	90	2796	0	8	354
15	5	5	39	141	145	319	3077	103	1	1334
16	8	7	5	303	399	115	4731	450	4	805
17	49	11	87	382	377	252	4328	88	3	1346
18	118	32	175	533	713	557	8426	423	8	2098
19	22	34	1872	1526	1607	296	10295	584	10	1922
20	14	31	162	946	341	230	7879	455	7	3589
21	27	35	251	757	779	488	7733	319	11	626
22	223	63	370	1497	1604	953	13221	1411	10	965
23	50	46	342	1560	599	776	10268	568	33	4644
24	22	23	232	1348	1358	358	8550	221	9	2431
25	45	44	223	1788	733	476	15014	637	35	5326
26	19	16	195	1018	357	359	6728	62	19	4058
27	20	32	233	1131	1220	344	17082	584	9	3015
28	1	6	38	137	161	106	3194	220	2	903
29	6	14	33	126	138	91	2033	115	2	790
30	4	6	47	257	288	191	5926	356	2	1423
31	17	12	17	189	259	49	756	144	1	355
32	51	170	86	408	497	612	4098	544	7	2001
33	27	32	228	1051	1182	292	14990	1923	8	2268
34	86	65	254	778	898	505	6185	722	15	3407
35	39	79	291	1471	633	590	12466	156	30	4723
36	16	19	91	314	311	83	2082	202	2	831
37	13	32	101	701	791	210	6397	731	3	1297
38	7	7	25	324	323	100	3394	67	1	1085
39	10	11	98	675	731	133	10026	151	5	1334
40	50	13	79	117	140	100	2040	1102	1	795
41	66	87	278	672	755	580	8378	2404	4	6628

It can be inferred that foods having maximal element content reveal positive information when compared on the basis of minimum daily allowance than maximum requirement consideration.

In average food, iron has good supply from the studied foods that can meet the minimum daily dietary allowance. The computed food averages have sufficient capacity to supply Ca, Mg, K and Mn. Other elements: $P < Se < Zn < Na < Cu < Fe$, in the order of magnitude, have fairly good values on average scale. Maximum dietary requirement can be met in the case of sodium element based on the computed average food values like *Banana leaf rice*. Maximum sodium intake can be obtained by adequate repeated intake per day as may be necessary.

The presence of these essential elements in the studied food is quite revealing. This study on the food is limited to how much elements the foods can supply. It is only an extended future study that would include formation about biological and bio-environmental systems that will affect food intake (Avula et al., 2010).

Table 7. Descriptive statistics of the elements contents of food and the Dietary Allowances [Recommended Nutrient Intake (RNI), Recommended Dietary Allowance (RDA), Acceptable Macronutrient Distribution Range (AMDR), Adequate Intake (AI) and Upper Limit (UL)]

	Mean	Min	Median	Maximum	Kurtosis	Skewness	DAmin	DAmax	a	b	C	D
Ca	50.08	1.03	22.13	399.80	10.88	3.18	800mg	1000mg	50.0	40.0	6.3	5.0
Mg	33.36	5.36	23.70	169.86	7.11	2.51	200mg	350mg	84.9	48.5	16.7	9.5
P	228.81	4.89	142.41	1872.48	15.91	3.73	580mg	1055mg	322.8	177.5	39.4	21.7
K	707.13	88.40	630.26	1788.06	-0.46	0.78	3500mg	4700mg	51.1	38.0	20.2	15.0
Na	655.68	108.33	550.31	2144.12	1.62	1.34	1200mg	1500mg	178.7	142.9	54.6	43.7
Cu	302.79	41.00	235.05	953.17	0.43	1.05	540µg	1000µg	176.5	95.3	56.1	30.3
Fe	6704.23	756.20	6184.84	17081.96	-0.17	0.74	8000µg	30000µg	213.5	56.9	83.8	22.3
Mn	529.36	0.00	433.36	2404.45	4.09	2.04	1800µg	23000µg	133.6	10.5	29.4	2.3
Se	10.13	0.53	7.19	35.24	0.47	1.23	23µg	33µg	153.2	106.8	44.0	30.7
Zn	2177.65	353.52	1383.11	7522.43	1.68	1.44	4300µg	9000µg	174.9	83.6	50.6	24.2

a = %Range max/DAmin, b = %Range max/DAmax, c = %mean/DAmin, d = %mean/DAmax DA = Dietary Allowance.

4. Conclusion

The adopted wet digestion procedure as well as the optimised Flame Atomic Absorption Spectroscopy (FAAS) and Inductively Coupled Plasma Mass Spectrometry (ICPMS) proved precise and accurate. The validated results of the method of analysing all-serving-units-inclusive foods showed better capturing of elements that are actually eaten than isolated-food methods. This is confirmed by the marked difference from the results published earlier on essential elements content of Malaysian foods. The foods are diverse in varying quantities of essential elements to offer wide choice range. *Banana leaf rice* and *Nasi beriani* appeared to be generally good source of most of all the essential major and trace elements. Others are only unique for certain elements. The comparison of the food contents of the essential elements with the Recommended Dietary Allowance (RDA) revealed that minimum requirements of the RDA can be met. This is possible through foods containing maximal quantities of the elements in question.

The study has proven the foods to be viable alternatives to supplementation. Proper choice decision has to be taken to obtain adequate essential elements of interest. Appropriately selected foods could therefore be exploited to play relevant roles in the solution to many mineral deficiency diseases (MDD).

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