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

Rasaq Bolakale Salau[1,2] & Mohamed Noor Hasan[1]

[1] Department of Chemistry, Faculty of Science, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Malaysia

[2] Department of Chemistry, School of Natural and Applied Science, Federal University of Technology, PMB 65, Minna, Nigeria

Correspondence: Mohamed Noor Hasan, Department of Chemistry, Faculty of Science, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Malaysia. Tel: 607-553-7852. E-mail: mnoor@utm.my

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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 | Serundig |
| 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$^{TM}$, Beschickung-loading model100-800). The temperature was set to 100-110$^0$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$^{TM}$ 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 $HNO_3$ (65 %,) and hydrogen peroxide $H_2O_2$ (40%) both of high purity, Grade AR QrëC$^{TM}$ laboratory preparation, New Zealand). De-ionized water (Milli-DI$^{TM}$, 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 $H_2O$ (mL)** | **+Conc. $HNO_3$ (mL)** | **+Conc. $H_2O_2$ (mL)** | **Heat Control** | **Observation** | **Time (min.) /Termination point** |
|---|---|---|---|---|---|---|
| 1 | Nil | 10 | Nil | Nil | Swollen, yellowish residue | Overnight |
| 2 | Nil | 5 | 2 | Low | Yellow solution | 20/ Nil |
| | | | | Medium | Blackish residue | 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 Current | 4.0Ma | Nitrous oxide flow rate | 4.7L $min^{-1}$ |
| Wavelength | Na(589nm),K(766nm)Ca(422.67nm), Mg(285.21 nm) | Aspiration rate | 3.2mL $min^{-1}$ |
| Type of Flame | $N_2O$-$C_2H_2$ | Slit width | 0.5nm |
| Temperature | $\leq 2600^0$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 mL$min^{-1}$ | Cu : 63 |
| Peak processing mode : Average | Plasma air flow rate : 15 L$min^{-1}$ | Sample read delay : 30s | Fe : 57 |
| Signal profile processing mode : Average | Nebulizer air flow rate : 0.96 L$min^{-1}$ | Spray chamber : Cyclonic | Mn : 55 |
| Detector mode : Dual | Auxiliary air flow rate : 1.05 L$min^{-1}$ | 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 $HNO_3$ is well pronounced far below the temperature of 120$^0$C 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 $11^{th}$ sample measured after every 10 determinations. This $11^{th}$ 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 ± 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 ± sd ( mg/g) | Measured m ± sd ( mg/g) | Recovery (%) | LOD |
|---|---|---|---|---|
| | | | | 0.098[a] |
| **Ca** | 15.27±0.04 | 15.02±0.45 | 98.4 | |
| **Mg** | 8.90±0.00 | 8.62±0.38 | 96.8 | 0.025[a] |
| **P** | 5.18±0.01 | 5.05±0.41 | 97.5 | 0.235[b] |
| **K** | 29.03±0.05 | 28.42±2.72 | 97.9 | 0.033[a] |
| **Na** | 18.18±0.04 | 18.74±1.02 | 103.1 | 0.013[a] |
| | 12.20±0.60 | | | |
| **Cu** | | 11.69±0.78 | 95.8 | 0.578[b] |
| **Mn** | 75.9±1.90 | 73.40±4.30 | 96.7 | 0.325[b] |
| **Se** | 0.117±0.01 | 0.110±0.01 | 94.0 | 0.388[b] |
| **Zn** | 82.00±3.00 | 83.80±4.31 | 102.2 | 0.012[b] |

m = mean, sd = standard deviation, a = mg/L, b = μg/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 Kwoczek, 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 derrived 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

| | mg per dried serving dish | | | | | | | | ug per per serving dish | |
|---|---|---|---|---|---|---|---|---|---|---|
| Code | 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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