Preliminary investigation of Malaysian foods for sourcing essential mineral micronutrients

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***Abstract*— Mineral deficiency disease (MDD) is top on global health issue. It is positioned by the United Nations records as the number one risk to health world-wide. Fortification and supplementation which are the main strategies to combat this scourge are artificial and could also cause side effects. This study aims at investigating Malaysian Foods capacity to supply the mineral nutrients, thus, preventing and remedying the cases. It is far more cost effective if commonly eaten foods can be shown to be a good source of these elements. In this preliminary study, the mineral micronutrient consisting of five essential major elements (Ca, Mg, P, K and Na), and five trace elements (Cu, Fe, Mn, Se and Zn) figured by United Nation as global deficits were determined in over 100 food samples availalable in Johor, Malaysia. The samples were dried, homogenised and wet digested with nitric acid and hydrogen peroxide. The elements were determined by flame atomic absorption spectrometry and inductively coupled plasma mass spectrometry. A descriptive statistics was carried out. All elements showed encouraging presence in all foods even in trace concentrations. The elements distributions were characterised at 95% confidence interval. The skewness value was not that low, indicating that the elements were not symmetrically distributed among studied foods. The kurtotic values were also high indicating a peaked clustered distribution. The overall preliminary study showed that some of the foods studied have self-sufficient and self-supplementing tendency to be relevant in the maintenance of mineral heath, remedy and even cure for many mineral malnutrition. In the future this study will employ the application of chemometrics methods to extract more information from the available data.**
Keywords: Mineral deficiency disease, micronutrient, fortification, supplementation, remedy, elements

I INTRODUCTION

Foods are chemical substances of nutritive and nourishment importance. Researches on food is therefore expected to show that a given food could confer nourishment to the body, qualitatively, quantitatively and affordable. 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 [1] and [2], father of orthomolecular medicine and a two-time Nobel prize winner (Chemistry and Peace), can be noticed in terms of the harm caused by low or non-presence of these elements [3] and [4]. 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 [6], [3], [7] and [8].

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, 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 such that nasi lemak, a rice and coconut milk based dish commonly called *nasi lemak* is often 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 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 are sourced from focus individually isolated foodstuff in either cooked, raw or both forms. These data would not adequately represent actual mineral intake as it omits the fact that foods are traditionally eaten in combined forms. 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 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 [9]. Countries may lose an estimated 2 -3 per cent of their Gross Domestic Product (GDP) as a result of iron, iodine, and zinc deficiencies [5].

In Malaysia there have been some reported cases anaemia (associated with iron deficiencies) [10], 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 [11]. [12] reported that the iron deficiency cases was nearly one million cases (969,645).

Osteoporosis (weak bones) cases, mineral deficiency diseases linked with poor intake of calcium, phosphorus and magnesium were also reported in Malaysia. In addition, Hip fractures as a result of osteoporosis were said to have affected 218 women and 88 men per 100,000 [13]. In a study [14], 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 [12].

The objective of this paper is to quantify five essential major and five essential trace elements in Malaysian ready-to-eat food in situ and evaluate the potentials of some of the food as source of these essential elements. The goal is therefore to show that commonly eaten food can be sufficient of these elements enough to discourage the use or administration of mineral supplements.

II MATERIALS AND METHOD

2.1 Samples, Sampling and Sample Standardisation

123 food samples containing 41 food types as eaten in Skudai- Johor area of Malaysia were selected for this study. Out of these, 26 were Malaysia Malay foods while 15 are Malaysia Indian foods. The restaurants used as samples are the well patronised restaurants in UTM-Skudai Campus, Taman University and Taman Sri Pulai.

Table 1: The selected Malaysian food samples

1	Soto nasi	22	Kuih talam
2	Mee rebus	23	Onde- onde
3	Nasi paprik	24	Pulut inti
4	Kangkung belacan	25	Roti canai
5	Ayam goreng kunyit	26	Maggi goreng
6	Nasi goreng kampung	27	Murtabak
7	Ikan asam pedas	28	Nasi beriani
8	Nasi lemak	29	Mamak rojak
9	Nasi berlauk	30	Ikan pari bakar
10	Nasi kerabu	31	Ayam percik
11	Mi hun soto	32	The tarik

12	Cili ketchup black	33	Chapati kima
13	Sambal sotong	34	Thosai
14	Apam balik	35	Banana leaf rice
15	Keropok Lekor	36	Rasam
16	Ketupat	37	Idli
17	Beef rendang with nasi	38	Sambar
18	Beef rending no nasi	39	Fish head curry
19	Roti jala with chicken curry	40	Roti naan with soup
20	Sayur lodeh	41	Pongal
21	Serunding		

The foods were purchased from the local restaurants. This was allowed to preserve their local identities and traditional values. In addition, to obtain standard and uniform information about food types and their component ingredients, major food websites and some experienced restaurants operatives were consulted. Furthermore, Standardised food description and ingredients chart was developed from combination of the information obtained from food websites with the ones of the sampled local restaurants.

2.2 Treatment and handling of samples

Three samples of each food type that are ordered from the three different locations (UTM- Skudai Campus, Taman University and Taman Sri Pulai) and were taken to the laboratory. To avoid bias, the foods sampled were the ready-to-eat and adult-size dishes, cooked and served by the restaurants. This is to simulate the way anyone who patronises the restaurant will eat. The food samples were taken in transparent polyethylene containers (for the foods) and leak proof nylon bags (for soups). Each of the fresh samples was 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 48 hours. 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.

2.3 Ashing and dissolution of samples

Wet ashing procedure with the mixture of Nitric acid and Hydrogen peroxide was used as in table 1. The boiling point of HNO_3 is 120^{0}C and its oxidising action is well pronounced far below this temperature. This moderate temperature safeguards the loss of some trace elements such as selenium, cadmium, lead, zinc, arsenic and nickel. The choice of hydrogen peroxide which is also an oxidizing agent was to contribute synergistic effect of oxidation of the samples. 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 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 and narrower neck of the flask were to allow, possibly, only gaseous bye product could escape while other material returns. The optimum digestion procedure adopted is described in table 2. Although, the freshly dissolved and digested solutions appeared as colourless or light yellow/brown clear solutions, it was still filtered with white filtered papers (ADVANTEC, qualitative filter papers, and 125 mm diameters) in readiness for instrumental analysis.

2.4 Instrumental determination of elements in the samples

Flame Atomic Absorption Spectrometer FAAS (PerkinElmer AAnalyst 400 with WinLab 32 computer software) was used to determine Ca, Na, K, Ca, Mn and Zn. 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, Se, P and Mg. The optimum operating conditions of the instrument was set by fixing and observing some parameters as indicated in table 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 as prepared from the Perkin Elmer laboratory, USA, were used. The stock solutions were drawn by means of micropipette (Eppendorf Reference^R Variabel).

2.5 Quality assurance and validation of techniques

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. While running the instruments, QC (quality control) samples were measured after every 10 determinations and percentage deviations were calculated. If greater than ± 5% then measurements were stopped, operating conditions including standard solutions checked and reset and re-prepared.

Quality assurance steps were taken in line with recommended best practice for technique validation[15]. 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), 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.

2.6 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.

III Results and discussions

3.1 Identity, weight and moisture contents of food samples

Although, most foods are rice based but differentiated by the names. By these names, it is possible to know the method of cooking and which other ingredients added to the rice or the manner in which it was prepared. Same thing goes for cooked fish and meat. Most Malaysian ready to eat meals are also served with soup and spices in varied quantities. These varieties that go along the basic foods add nutrient values to the ready-to eat foods. For this reason any attempt to study the food in fractions rather than the in-situ as in this study may not be able to reveal the foods' wealth of nutrients. Since it is customary to serve food with soups and spices, it is expected that served foods are substantially weighty. In the process of analysis, it was the dried sample that was eventually used. Table 5 and figure 1 reveal the weight parameters of the served Malaysian foods.

Most sampled foods have high water content as revealed by the high moisturizing coefficient. Since it was the dried food that was treated for the determination of the minerals, it follows that multiplying this coefficient with the mean dried food weight; it is possible to have the idea of the amount of nutrients contained in the originally served fresh food. The bulkiest food, both at fresh and dried weight, is found to be Banana leaf rice. The mean dried weight was 276.5g. The reported elements' content is expressed in per 100g. This implies that it can supply almost three times of the reported contents in table 5. The data generated based on fresh and dry mass as well as the moisturisation co-efficient are needed to further prove the potentials of the Malaysian foods for sourcing micronutrients being studied.

3.2 Element contents of Malaysian foods

Tables 6, as well as figures 1 and 2 show the concentrations of the elements present in all the sampled foods. The order of the magnitude of the elements Mg < Ca < P < Na < K are normal for what is universally expected of foods capable of supplying adequate mineral nutrients. The Ca:P molar ratio fall within the allowable intake [16] and fairer than the case reported of Finnish women by [17]. Low calcium: phosphorus ratio in diets has effect on serum parathyroid, bone mineralisation and calcium metabolism [17]. Similarly, another index of looking at healthy food is K: Na ratio which is also observed in the mineral distribution in the studied foods. The higher the K: Na ratio the richer is the food and the less risk of some heart related diseases [18].The trace elements also have moderate presence in average food [19] and [20]. The implication of all this, is that it is possible to select the right food among the broad studied list that be relevant and of great health importance.

Each of these elements has good presence in some handful of food samples. The list of top five samples substantially containing the elements are : Calcium (39,31,30,35 and 36), Magnesium (25, 36,30,39 and 20), Phosphorus (2,39,31,30 and 7), Potassium (7,20,4,12 and 36), Sodium (36,20,4,1 and 8), Copper (25, 33, 16, 12 and 13), Iron (1, 19, 20, 4 and 18), Manganese(32, 19, 37, 34and 20), Selenium (7,12, 30. 39 and 13) and Zinc (34, 31, 18, 13 and 11).

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 nature of the elements. The distribution was therefore tailed towards more positive values. The kurtotic values were also high indicating a peaked clustered distribution relative to the normal distribution. The negative kurtotic value obtained in the case of potassium distribution indicates an exceptional high values which contributes to the flatness of the distributions. The range values of represented wide extreme values. This statistics revealed wide divergence of minerals across the sampled foods. This wide disparity further gives credence to the fact that the foods have divergent values.

3.4 The foods content and comparisons with Recommended Dietary Allowance

The foods content data value in table 7, figures 4, 5 and 6 gave RNI / RDA compared with the elements content of the foods. The Required nutrient intake (RNI) and Recommended Dietary Allowance (RDA) values obtained from Malaysian and United States dietary guideline respectively can be compared with the value obtained as element contents of the foods. Some of the studied foods can be good source of the essential elements. This is because some foods are capable of supplying these essential elements up to 60% and above. This assertion is based on the fact that there is room for repetition of the food same day. In addition, the per 100mg presentation of the element content is not absolute. Some of the foods actually served as ready to eat are twice or more than the 100mg as earlier discussed and shown in figure 1. For instance, single served average plate of Nasi berlauk and Banana leaf rice are respectively 206.9g and 276.5g dry weight, this mean they contain more than twice the reported table 6 values. Figures 4 and 5 illustrate this comparison and the inherent capacity of foods to meet the RDA values.

IV Conclusion

This study clearly shows the selected food samples and their in-situ analysis have great profile in terms of essential elements contents. Most Malaysian ready to eat meals are also served with soup and spices in varied quantities, hence determination of the whole ready-to-eat food appeared to further expose the foods' wealth of nutrients. Both the essential and trace elements have moderate presence in average food. The implication of all this, is that in terms of prevention, remedy or cure of Mineral deficiency diseases, there is wide range of choice of foods among the broad studied list that will be relevant and of great health importance. This statistical analysis revealed wide divergence of minerals across the sampled foods, thereby giving credence to food sample containing wide spectrum of beneficial elements. The closeness of virtually all the studied elements with the Required Nutrient intake suggests that the foods can be shown to have self-sufficient and self-supplementing tendency to be relevant in the maintenance of heath and combat mineral malnutrition. Household budget that would have been expended on mineral supplement can be saved, some diseases would be prevented and a healthier nation hood is sustained.

The preliminary study needs to be extended to use and application of chemometrics. Firstly, it will be a novel application since there is paucity of literature as far as analysis of the sub regional ready to eat food is concerned. Chemometrics can be used to extract fuller information. The Principal component analysis (PCA) would describe and interpret major patterns of similarities and co-variation in food samples. Cluster Analysis (CA) and Linear Discriminant Analysis (LDA) techniques can be applied on the data set for recognizing and classifying the inter-relationships and similarities of foods based on their element contents.

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

Table 3: Operating parameters for Flame Atomic Absorption Spectrometer

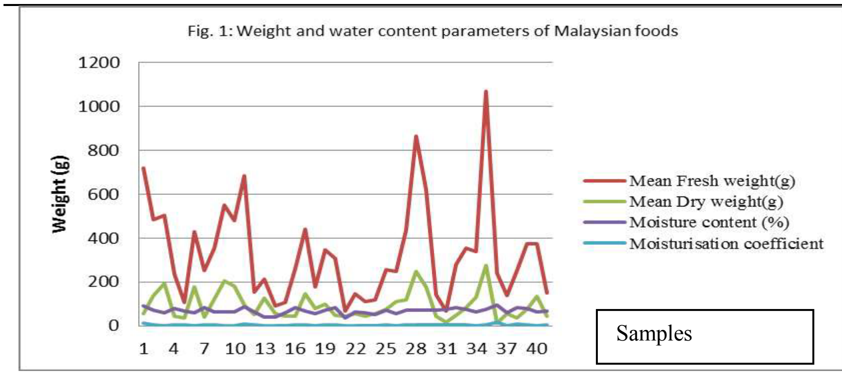
Parameters	**Conditions**	**Parameters**	**Conditions**
Hollow Cathode Lamp Current	4.0mA	Nitrous oxide flow rate	4.7L min^{-1}
Wavelength	Na(589nm),K(766nm)Ca(422.67nm), Mn(279.50nm), Zn(213.86)	Aspiration rate	3.2mL min^{-1}
Type of Flame	N_2O-C_2H_2	Slit width	0.5nm
Temperature	≤ 2600^0C	Burner Height	13.5mm
Background Correction	Deuterium Lamp	Blank solution	De-ionized water (Milli-DI^{TM}, Millipore)
Acetylene flow rate	4.2L min^{-1}	Operating environment	25-30^0C

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	Mg : 24
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)	
Dead time : 35ns		Operating environment : 25-30^0C	
Dwell time : 100ms			
Integration time : 900ms			

Table 5 Summary of Weight and water content of Malaysian foods (n =123)

Food samples	Mean Fresh weight(g)	Mean Dry weight(g)	Moisture content (%)	Moisturisation coefficient
Average	330.71	94.45	68.49	4.12
Range (Upper Limit)	1069.59	276.56	94.01	16.69
Range Lower Limit)	68.24	14.36	34.76	1.53
Standard deviation	223.53	64.27	13.22	2.88



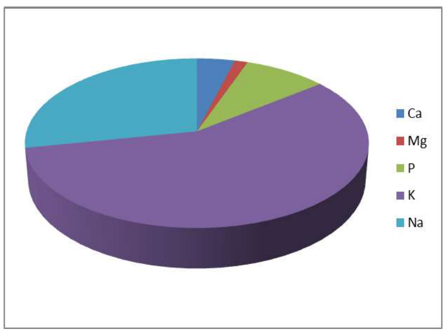


Fig 2 Essential major elements in ave. food.

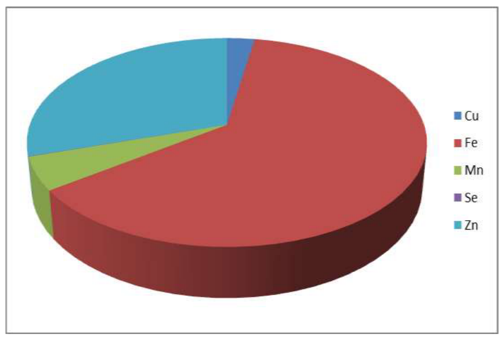


Figure 3 Essential trace elements in average food.

Table 6 Essential major element contents (mg/100g) and trace elements contents (µg/100g) of dried food samples

	Food samples	Ca	Mg	P	K	Na	Cu	Fe	Mn	Se	Zn
1	Soto Nasi	37.9	19.3	178.1	2454.8	1329.6	242	18,225	275	4.13	3,638
2	Mee Rebus	32.4	24.7	1363.7	2222.2	1170.4	216	7,498	425	3.68	2,100
3	Nasi Paprik	20.1	16.6	119.7	1162.8	627.3	177	8,783	300	2.24	2,325
4	Kangkung Belacan	115.2	33.3	199.5	2919.9	1554.3	259	12,060	500	5.55	4,238
5	Ayam Goreng Kunyit	62.4	39.3	295.3	1834.6	955.1	306	11,060	300	5.33	2,700
6	Nasi Goreng Kampung	25.0	12.9	131.0	1524.5	767.8	202	4,835	125	2.60	2,063
7	Ikan Asam pedas	99.6	39.6	457.6	3139.5	749.1	303	7,420	1,400	26.91	3,525
8	Nasi Lemak	30.8	13.0	158.3	1653.7	290.3	292	5,468	50	7.60	4,946
9	Nasi Berlauk	48.6	22.3	165.6	1511.6	290.3	376	4,975	275	8.06	3,375

10	Nasi Kerabu	49.2	24.1	122.3	1963.8	402.6	261	8,245	350	9.68	4,388
11	Mi Hun Soto	29.3	32.3	169.7	1976.7	355.8	241	8,233	475	3.46	5,625
12	Cilli ketchup	19.8	18.0	78.7	2687.3	739.7	510	10,163	25	24.74	3,938
13	Black Sambal sotong	63.0	63.0	232.2	2351.4	505.6	471	9,965	125	12.16	5,663
14	Apam Balik	17.2	43.8	155.4	1253.2	786.5	280	6,935	800	1.03	3,263
15	Keropok Lekor	47.5	21.5	125.7	2196.4	1245.3	204	6,328	0.00	9.58	1,200
16	Ketupat	23.7	11.8	85.7	620.2	318.4	699	6,748	225	1.09	4,388
17	Beef Rendang with Nasi	59.6	26.1	178.9	1834.6	1001.9	220	6,765	400	3.29	4,350
18	Beef Rendang no Nasi	31.4	32.5	203.6	1808.8	1254.7	285	11,673	375	10.90	6,113
19	Roti Jala with Chicken curry	54.4	31.9	230.7	2131.8	1198.5	296	15,200	1,950	4.21	3,450
20	Sayur Lodeh	56.5	67.2	213.7	2971.6	1676.0	445	13,563	1,550	3.34	4,125
21	Serundig	31.2	16.0	56.6	1447.0	721.0	223	7,585	150	0.85	3,638
22	Kuih Talam	28.5	13.3	9.0	1111.1	730.3	210	8,668	825	3.80	2,213
23	Onde-Onde	4.7	12.8	87.0	620.2	365.2	240	7,253	500	2.66	3,075
24	Pulut Inti	13.2	10.7	82.1	904.4	505.6	336	10,413	625	1.51	3,750
25	Roti Canai	137.3	227.9	115.6	1095.6	666.7	821	5,499	730	4.83	4,028
26	Maggi Goreng	89.8	9.8	79.2	697.7	344.6	230	3,954	80	1.34	1,845
27	Murtabak	46.2	29.5	212.5	1281.7	659.2	413	6,543	270	4.81	795
28	Nasi Beriani	179.9	25.6	149.6	1209.3	647.9	385	5,342	570	2.12	585
29	Mamak Rojak	133.5	18.1	99.3	604.7	404.5	316	4,780	240	2.32	1,785
30	Ikan Pari Bakar	466.3	69.7	593.9	1178.3	797.8	250	7,239	990	19.98	4,125
31	Ayam Percik	533.5	36.5	762.6	1137.0	696.6	264	7,169	360	5.66	7,290
32	Teh Tarik	212.4	27.8	166.8	496.1	295.9	212	4,313	2,330	1.13	2,520
33	Chapati Kima	149.4	40.9	172.5	1100.8	618.0	718	7,989	590	2.80	4,080
34	Thosai	102.0	66.7	214.2	1033.6	580.5	446	6,446	1,850	1.42	7,650
35	Banana leafRice	289.1	52.5	369.8	1292.0	775.3	268	4,589	800	5.50	4,080
36	Rasam	234.6	84.0	116.8	2625.3	1805.2	338	5,266	1,000	1.83	3,705
37	Idli	69.4	32.7	202.9	1974.2	1209.7	236	4,455	1,950	2.48	4,155
38	Sambar	83.3	50.7	243.4	1674.4	831.5	223	5,559	540	2.13	3,330
39	Fish Head Curry	723.8	67.8	1158.8	1317.8	786.5	305	8,092	630	15.44	5,475
40	Roti Naan (with soup)	126.2	47.7	186.4	1142.1	659.2	371	4,538	530	5.40	3,750
41	Pongal	27.9	31.3	71.9	547.8	299.6	198	4,429	250	2.10	2,580

Table 7. Descriptive statistics of the elements contents of food

	RANGE					RDA			
Elements	**Mean mg/100g**	**Min mg/100g**	**Max mg/100g**	**Kurtosis**	**Skewness**	**min(mg)**	**max(mg)**	**% Range max/RDA max**	**% Range max/RDA min**
	112.3	4.67	723.8	7.87	2.73	800		72	90
Mg	38.2	9.80	227.9	19.91	3.93	200	350	65	114
P	244.3	8.95	1363.7	9.21	2.98	580	1055	129	235
K	1578.3	496.1	3139.5	-0.54	0.48	3500	4700	67	90
Na	771.2	290.3	1805.2	0.37	0.91	1500	1500	120	120
Cu	0.324	0.177	0.821	3.88	1.97	0.540	1.000	82	152
Fe	7.665	3.954	18.225	2.41	1.45	8.000	30.000	61	228
Mn	0.628	0.000	2.330	1.70	1.53	1.800	2.300	101	129
Se	0.006	0.001	0.027	4.55	2.17	0.023	0.034	79	117
Zn	3.655	0.585	7.650	0.66	0.40	4.300	10.000	77	178

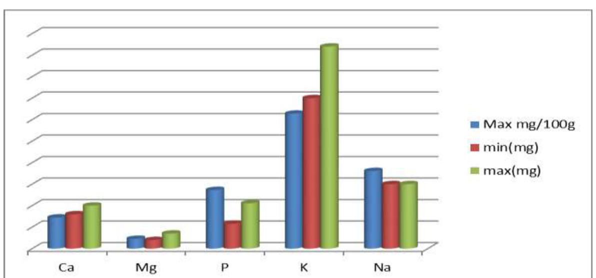


Fig 4 : major elements and RDA

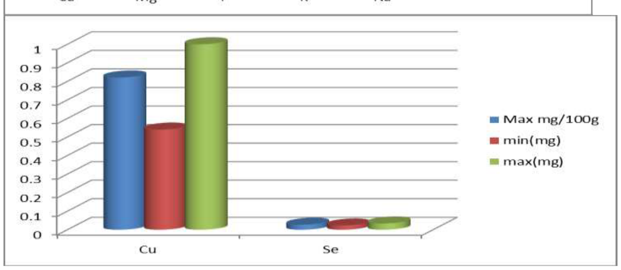


Fig. 5 : Cu,Se and RDA

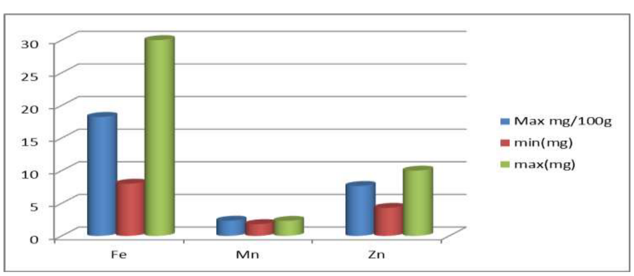


Fig. 6 : Fe, Mn, Zn and RDA

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