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# Essential and Trace Elements in Different Pulses, Spices and Vegetables

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**Abstract**

The amounts of bio-chemically important elements for human bodies such as Na, K, Ca, P, Mg, Fe and Cu in some widely used pulses and spices in Chittagong were determined by using flame photometry and UV-Visible spectrophotometry. Similarly, the amounts of Mg, Fe and Cu in some leafy and non-leafy vegetables available in Chittagong were determined by the UV-Visible spectrophotometric method. The essential elements such as Na, K, Ca and P were found in mg/kg levels. The amounts of trace metal such as Mg, Fe and Cu in pulses and spices were just within the range of human necessity. However, the amounts of Mg, Fe and Cu in leafy and non-leafy vegetables were so negligible that they can not be considered as adequate for health, except their food-values constituted by the higher contents of starch.

## Introduction

The essential elements, such as Na, K, Ca and P have vital roles in the biological functions of human bodies. Sodium and potassium act as electrolytes in the body-fluid to control the nerve and cardiac functions. But calcium and phosphorus, in addition to the formation of bone, teeth and body-skeleton, have to perform a number of other biological functions, such as transmission of nerve impulses, activation of enzymes, carrier of genetic information and energies. Hence, each of these elements is to be present in human bodies in gram quantity. The trace elements, such as Mg, Fe and Cu, being the central parts of important globular bio-molecules, have to be present in milligram scale. However, for proper functioning of different organs and systems, the amount of every such element should be in a certain range [1]. If they exceed their upper limit, the biological balance of the body is disturbed and the system becomes unstable. On the other hand, if their amount is below the lower limit, then their deficiencies produce different diseases. For maintaining a good health, it is important to keep these elements in their proper ranges by personal initiative. This type of self-controlling can be done by selecting appropriate foods for daily diets from a list which can provide information about the metal-contents of different foods. In order to make such a list of foods, the widely used pulses, spices and vegetables by the general people of Chittagong are studied to estimate the amounts of seven important elements and the results are described in the following sections.

## Experimental

### *Sample preparation*

The selected varieties of pulses, spices and vegetables were collected from the markets of Chittagong town. The cleaned and weighed portion of a fresh sample was first dried in an oven at 110–120°C to remove moisture and then burnt in a muffle furnace at 800–950°C until a white or gray ash of constant weight was left in the crucible. All the samples under present investigation were made ashes in the same way

and stored in stoppered bottles until they were used for spectroscopic measurements.

### *Analytical Techniques*

The chemicals and reagents used for analysis were of the AR grade and distilled water was used in preparation and dilution of all solutions. Stock solutions of different primary standard compounds (Table 1) were first prepared and the standard solutions of different concentrations were made by diluting these stock solutions and were used for preparing calibration curves. For spectroscopic measurement of each sample, a weighed portion of the ash was dissolved in a mixture of acids, and the necessary complexing agents and buffer solutions were added [2–9]. A blank solution was prepared for each sample by using all the reagents except the ash and its absorbance was used to adjust the zero of the instrument. The absorbances of the solution of samples were recorded within 20–30 minutes of preparation. All the spectroscopic measurements of the standard as well as the same sample solutions were done at their $\lambda_{max}$ (Table 3). The absorbance of the phosphorus, magnesium, iron and copper solutions were recorded by a Shimadzu (Model–160) double beam UV–visible recording spectrophotometer and the percentage luminosities of sodium, potassium and calcium were recorded by a flame photometer (Model–10 ALA or Model UFB–6, 10AL) and these values were used in respective calibration curves to determine the amounts of the elements in the samples in ppm or mg/kg units.

### Results and Discussion

Data in Table 1 depicts that pulses and dried spices had low moisture content in the range of 9.1-14.66 and 4.42-12.83 percent respectively and their organic matter content was high (more than 80%). On the other hand fresh spices and fresh vegetable (Table 2) both leaf and non-leafy had high moisture levels with low organic matter values.

The amounts of elements determined in different pulses, spices and vegetables available in Chittagong are presented in Table 4, 5 and 6 respectively. The amount of same elements in the pulses of different places of the world collected from journals and reference books are given in parentheses for comparison [10–14]. The data in table 4 indicate that the amount of essential elements such as Na, K, Ca and P in the pulses of Chittagong are in the range (0.10–10.0), (0.01–8.10), (0.50–25.0) and (5.0–29.5) mg/kg respectively. Figures for these elements, in our findings, in most cases are either too high or too low than those reported in literature. Green gram had the lowest sodium content (0.17mg/kg) which is 53 times less than reported in the literature. Similarly lablab had 9 times less potassium content than reported values. Similarly pulses had very low calcium content than those reported in the literature and as low as 20 times low for peas. Except for Lablab all the other pulses had higher Mg content than reported previously. Similarly Chitagong pulses had too high iron and copper content. It is possible that Chitagong vegetables have special genetic characteristic that enables the pulses selectively to bioaccumulate the Mg, Fe and Cu.

These amounts of Na are at least one thousand times less than their recommended levels [1]. The data in the parentheses, being very close to the data obtained in the present investigation, suggest that the pulses and the spices naturally contain very poor amounts of Sodium but Sodium is easily overcome by adding common salt in the food. However, the amounts of trace elements, Mg (2.20–25.5), Fe (12.9–55.3) and Cu(0.85–7.50) mg/kg in the pulses, and Mg(4.40–94.8), Fe(6.3–120.3) and Cu(0.5–31.3) mg/kg in spices are in the expected levels.

The amounts of trace elements, Mg (1.0–30.0), Fe(0.01–2.5) and Cu(0.02–0.75) mg/kg in leafy vegetables, and Mg(1.0–31.0), Fe(0.25–0.85) and Cu(0.60–2.20)mg/kg in non-leafy vegetables in Table 6 are actually much less than reported in the literature. However, the unexpectedly lower amounts of metals in these vegetables are found to be consistent with the amounts of same metals such as Mg(0.25–25.0), Fe(0.75–20.0) and Cu(0.10–1.10)mg/kg in some other vegetables [15]. But the amounts of Mg, Fe and Cu in different fishes were found to be 200–600, 5–10 and 1–3 mg/kg respectively [16] which are at least hundred times higher than in vegetables. These data indicate that the trace metals are

much less abundant in Chittagong vegetables than in fishes. It is suggested that blend of pulses or fish with vegetables may make a perfect diet having balanced levels of proteins, vitamins and minerals. Moreover, the higher percentage (*ca.* 80%) of organic materials (Table-1) in these foods can make them significant because the spices may contain essential digestive enzymes while the pulses may be rich in proteins.

**Table 1. Percentage of moisture, organic material and inorganic material in Pulses and Spices of Chittagong.**

| Pulse | % of moisture | % of organic materials | % of inorganic materials | Spice | % of moisture | % of organic materials | % of inorganic materials |
|---|---|---|---|---|---|---|---|
| Lentil | 12.60 | 85.15 | 2.24 | Coriander | 9.28 | 75.91 | 14.80 |
| Black gram | 13.00 | 83.19 | 2.38 | Nigella | 7.06 | 92.72 | 0.34 |
| Gram | 10.16 | 86.99 | 2.84 | Black piper | 4.42 | 91.29 | 4.28 |
| Green gram | 13.53 | 83.39 | 3.07 | Poppy seed | 5.84 | 87.52 | 6.63 |
| Pigeon pea | 15.37 | 80.81 | 3.81 | Aniseed | 9.83 | 83.35 | 6.81 |
| Pea | 14.66 | 83.19 | 2.13 | Red Chilli | 12.83 | 86.89 | 3.46 |
| Cow pea | 13.09 | 83.10 | 3.80 | Turmeric | 81.26 | 17.42 | 1.32 |
| Lablab | 11.31 | 85.47 | 3.21 | Onion | 85.91 | 14.03 | 0.56 |
| Garden pea | 9.10 | 88.12 | 2.77 | Ginger | 80.42 | 19.43 | 0.62 |
| Lima bean | 10.40 | 85.43 | 4.17 | Garlic | 35.31 | 64.23 | 0.25 |
| Grass pea | 13.30 | 83.08 | 3.61 | Green Chilli | 84.28 | 14.72 | 0.99 |
| | | | | Cumin | 8.68 | 83.32 | 9.12 |

**Table 2. Percentage of moisture, organic material and inorganic material in vegetables.**

| Leafy vegetable | % of moisture | % of organic materials | % of inorganic materials |
|---|---|---|---|
| Hubbard squash | 84.20 | 14.32 | 1.48 |
| Bottle gourd | 81.29 | 17.41 | 1.30 |
| Radish | 85.41 | 11.65 | 2.94 |
| Indian mustard | 78.41 | 17.04 | 4.55 |
| Mustard | 88.58 | 10.33 | 1.09 |
| Taro | 84.40 | 14.75 | 0.85 |
| Water spinach | 85.71 | 12.85 | 1.44 |
| Indian spinach | 91.44 | 7.24 | 1.32 |
| Dheki shak | 89.40 | 10.05 | 0.55 |
| Alligator weed | 89.45 | 9.76 | 0.79 |
| Spinach) | 91.73 | 7.75 | 0.52 |
| Amaranth | 86.39 | 11.08 | 2.53 |
| Ganges primrose | 82.99 | 14.16 | 2.85 |
| Asiatic coinwort | 90.28 | 9.1 | 0.62 |
| **Non-leafy vegetable** | | | |
| Carrot | 88.18 | 10.99 | 0.83 |
| Brinjal | 92.37 | 7.11 | 0.52 |
| Radish | 93.47 | 5.61 | 0.92 |
| Lablab | 86.14 | 11.74 | 2.12 |
| Okra | 90.55 | 9.00 | 0.45 |
| Tomato | 93.18 | 6.33 | 0.49 |
| Bitter gourd | 92.12 | 6.76 | 1.12 |
| Banana | 80.25 | 19.48 | 0.27 |
| Borboti | 87.34 | 11.62 | 1.04 |
| Papaya | 88.25 | 10.83 | 0.92 |

Table 3. Standard reagents for calibration curves and (max for the elements studied.

| Element | Standard reagent for preparing calibration curves | Wavelength of maximum absorption/nm |
|---|---|---|
| Na | NaCl | 589.0 |
| K | KCl | — |
| Ca | CaCO3 | 422.7 |
| P | KH2PO4 | 724.0 |
| Mg | MgSO4.7H2O | 529.0 |
| Fe | $FeNH_4(SO_4)_2.12H_2O$ | 512.0 |
| Cu | $CuSO_4.5H_2O$ | 434.0 |

**Table 4. Amount of elements in some pulses available in Chittagong, Bangladesh.**

| English (Biological) name of the pulse | Amount in mg/kg | | | | | | |
|---|---|---|---|---|---|---|---|
| | Na | K | Ca | P | Mg | Fe | Cu |
| Lentil(Lens culinaris) | 3.20 (6.02) | 0.57 (2.57) | 5.45 (8.54) | 6.8 | 12.2 (2.03) | 35.8 (4.50) | 2.62 (0.89) |
| Black gram(Phaseolus mungo) | 4.51 (7.02) | 0.31 (1.31) | 2.07 (6.07) | 11.5 | 10.0 (0.34) | 24.4 (3.50) | 3.45 (0.13) |
| Gram (Cicer arientum) | 0.37 (2.30) | 1.25 (1.25) | 1.15 (8.10) | 17.5 | 4.7 (1.53) | 21.2 (0.12) | 0.95 (0.35) |
| Green gram(phaseolus aureus) | 0.17 (8.94) | 0.68 (0.35) | 0.64 (12.04) | 8.5 | 21.0 (0.98) | 12.9 (0.80) | 6.28 (0.64) |
| Pigeon pea(Cajanus cajan) | 2.61 (9.30) | 1.51 (2.04) | 1.04 (13.64) | 9.1 | 14.0 (5.39) | 48.9 (3.20) | 1.33 (0.86) |
| Pea (Pisum Sativum L) | 0.79 (7.43) | 6.69 (5.67) | 0.88 (17.65) | 9.7 | 19.4 (6.78) | 15.7 (1.70) | 0.99 (0.34) |
| Cow pea(Vigna ungniculata L) | 4.39 (3.04) | 2.30 (7.02) | 2.19 (18.60) | 5.4 | 5.4 (1.65) | 55.3 (4.30) | 2.74 (0.35) |
| Lablab (Dolichos lablab L) | 0.24 (5.06) | 0.96 (8.30) | 1.10 (19.80) | 7.3 | 2.2 (7.65) | 44.6 (14.6) | 7.49 (0.04) |
| Garden pea(Pisum arvense) | 8.49 (7.07) | 1.40 (9.10) | 1.31 (10.0) | 5.0 | 14.1 (3.60) | 28.8 (8.70) | 0.85 (0.15) |
| Lima bean(Phaseolus vnigaris L) | 9.84 – | 1.31 (6.80) | 1.05 – | 7.3 | 25.5 (1.90) | 26.6 (9.60) | 0.88 (0.33) |
| Grass pea(Lathyrus sativus) | 5.70 (8.34) | 5.81 (7.90) | 0.51 (6.18) | 6.5 | 21.0 (6.30) | 41.9 (18.8) | 2.78 (0.19) |

**Table 5: Amount of elements in spices available in Chittagong, Bangladesh.**

| English (Biological) name of the spice | Amount in mg/kg | | | | | | |
|---|---|---|---|---|---|---|---|
| | Na | K | Ca | P | Mg | Fe | Cu |
| Coriendar(Coriendrum sativam) | 0.72 | 3.87 | 10.9 | 19.1 | 38.4 | 120.3 | 15.5 |
| Nigella (Nigella sativa) | 1.98 | 2.94 | 8.1 | 12.0 | 25.6 | 110.2 | 6.4 |
| Black Piper(Piper nigrum) | 0.57 | 4.78 | 9.6 | 18.3 | 39.0 | 64.9 | 7.6 |
| Poppy seed (Pastacia vera) | 0.36 | 1.68 | 4.1 | 28.0 | 19.7 | 61.6 | 5.4 |
| Aniseed (Foeniculum vulgare) | 6.47 | 8.09 | 25.6 | 6.0 | 67.6 | 39.8 | 6.2 |
| Red Chilli (Capcicum annuum) | 0.41 | 1.20 | 2.6 | 29.1 | 87.4 | 32.6 | 4.8 |
| Turmeric (Curcuma longa) | 0.37 | 0.01 | 1.8 | 8.3 | 4.4 | 16.3 | 0.9 |
| Onion (Allium cepa) | 0.23 | 0.63 | 1.5 | 5.7 | 17.7 | 10.3 | 1.6 |
| Ginger (Zingiber officinale) | 0.05 | 0.42 | 0.7 | 7.2 | 13.5 | 9.0 | 4.2 |
| Garlic (Allium sativum) | 0.42 | 1.29 | 1.4 | 9.3 | 16.9 | 8.5 | 0.5 |
| Green Chilli (Capcicum frutescens) | 0.28 | 1.30 | 2.9 | 8.0 | 13.4 | 7.1 | 31.3 |
| Cumin (Cuminum Cyminum) | 4.21 | 7.27 | 16.4 | 16.1 | 94.8 | 6.3 | 5.7 |

**Table 6. Amount of trace metals in vegetables available in Chittagong.**

| Local (Biological) name of leafy vegetables | Amount in mg/kg | | |
|---|---|---|---|
| | Mg | Fe | Cu |
| Hubbard squash (Cucurbita maxima) | 7.92 | 0.62 | 0.11 |
| Bottle gourd (Lagenaria Vulgaris) | 11.01 | 1.00 | 0.02 |
| Radish (Raphanus sativus) | 6.15 | 0.68 | 0.13 |
| Indian mustard (Brassica juncea) | 17.51 | 2.50 | 0.46 |
| Mustard (Brassica Sp.) | 9.95 | 0.82 | 0.06 |
| Taro (Colocasia esculenta) | 16.11 | 0.10 | 0.09 |
| Water spinach (Ipomoea aquatica) | 11.65 | 0.70 | 0.31 |
| Indian spinach (Basella rubra) | 25.58 | 0.01 | ND* |
| Dheki shak (Lteris sp.) | 0.95 | 0.73 | 0.05 |
| Alligator weed (Alternanthera Philoxeroides) | 5.78 | 0.40 | 0.16 |
| Spinach (Spinacea oleracea) | 30.28 | 1.87 | 0.41 |
| Amaranth (Amaranthus tricolor) | 7.87 | 0.07 | 0.76 |
| Ganges primrose (Amaranthus gangetica) | 14.68 | 0.33 | 0.07 |
| Asiatic coinwort (Centella asiatica) | 6.65 | ND* | 0.15 |
| **Local (Biological) name of non-leafy vegetable** | **Mg** | **Fe** | **Cu** |
| Carrot (Daucus carota) | 16.92 | 0.83 | 0.62 |
| Brinjal (Solanum melongena) | 11.71 | 0.53 | 1.00 |
| Radish (Raphanus sativus) | 1.01 | 0.26 | ND* |
| Lablab (Lablab purpureus) | 13.09 | 0.39 | 1.01 |
| Okra (Abelmoschus esculentus) | 31.56 | 0.51 | 0.92 |
| Tomato (Lycopersicon lycopersicum) | 8.40 | 0.26 | 1.46 |
| Bitter gourd (Momordica charantia) | 29.46 | 0.27 | 0.85 |
| Banana (Musa sapientum var. pardisiaca) | 5.58 | 0.28 | 1.15 |
| Borboti (Vigna sinensia) | 3.76 | 0.26 | 0.66 |
| Papaya (Carica papaya) | 12.11 | 0.43 | 2.18 |

**ND*= Not detected**

## Conclusion

To maintain a good health, the people should take balanced diets which contain the requisite amount of the essential and trace elements and our studies clearly indicate that mixing of pulses with vegetables may help in maintaining balanced dietary intake of essential elements. If any person has deficiency of any of these elements, he/she should consult the expert health practitioner to prescribe necessary medicines and selective foods to compensate the desired element in the body. But the most effective measure against the deficiency of metals and minerals or their toxicity on public health can be taken by the joint effort of the STI and the Government health departments by monitoring these parameters in food-industries and confectioneries. In any disaster caused by a metal-deficiency or metal-poisoning, the health department should extent direct cooperation through health complexes to ensure necessary medical help to the victims so that they may be sure to be cure.

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