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Chemical Compostion of Mineral Fortification and Supplementationuses of Mineral Isotope Tracers: Nutritional Studies

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Abstract
Health authorities in all countries are concerned about the nutrition of their population. In the industrialized world, major concerns are related to what has been called "over nutrition". With higher affluence and urbanization, diets tend to become higher in energy and fat, especially saturated fat. They also have less fibre and complex carbohydrates, and more alcohol. These and other risk factors are leading to increased incidence of obesity, hypertension, cardiovascular diseases, diabetes mellitus, osteoporosis, anaemia and some cancers, with immense social and health care costs. For developing countries, the problems chiefly lie on the other end of the spectrum. "Under nutrition", or malnutrition, is the principle enemy, mainly of poor people who experience the most widespread and severe effects of malnutrition.

Key Word: health, isotops, minerals, nutrition , malnutrition etc .

Introduction

MINERAL FORTIFICATION
There are three main types of intervention to prevent and combat vitamin and mineral deficiencies, which can be deployed individually or in combination: short-term supplementation; medium-term food fortification; and a long-term focus on balanced nutrition (dietary diversification).

I. Supplementation
II. Food fortification
III. Dietary diversification

I. Supplementation
Food supplements are highly concentrated vitamins and minerals produced by pharmaceutical manufacturers in the form of capsules, tablets or injections and administered as part of health care or specific nutrition campaigns.

Types of Food Supplements: There are many types of food supplements.

1. Vitamins: Vitamin is an organic compound required by an organism as a vital nutrient in limited amounts. An organic chemical compound (or related set of compounds) is called a vitamin when it cannot be synthesized in sufficient quantities by an organism and must be obtained from the diet. For example, ascorbic acid (vitamin C) is a vitamin for humans, but not for most other animals. Vitamin supplement is important for the treatment of certain health problems but there is less evidences of benefits when it is used in healthy person.

2. Dietary supplements: These are required by living organisms, other than the four elements carbon, hydrogen, nitrogen, and oxygen present in common organic molecules. The term "dietary mineral" is archaic, as the substances it refers are chemical elements rather than actual minerals.

3. Herbal medicine: Plants have been the basis for medical treatments through much of human history, and such traditional medicine is still widely practiced today. These are the form of alternative medicine, is not strictly based on evidences collected by the scientific methods. Modern medicine uses many plant-derived compounds as the basis for

evidencetested pharmaceutical drugs, and physiotherapy works to apply modern standards of effectiveness testing to herbs and medicines that are derived from natural sources.

4. **Amino acids and proteins**: These are important organic compounds consists of of amine (-NH2) and carboxylic acid (-COOH) functional groups, along with a side-chain specific to each amino acid. Carbon, Hydrogen, Oxygen, and nitrogen are the major elements of Amino acids, though other elements are found in the side-chains of certain amino acids. Amino acids can be divided into three categories: essential amino acids, non-essential amino acids, and conditional amino acids. Human body cannot synthesis Essential amino acids, and must be supplied by food. Non-essential amino acids are made by the body from essential amino acids or in the normal breakdown of proteins. Conditional amino acids are not essential, apart from conditions like illness, stress, or for someone challenged with a lifelong medical condition.

5. **Essential fatty acids:** These are also very important for good and healthy growth of human body. Essential fatty acids are the important elements that humans and other animals must ingest because the body requires them for good health but cannot synthesize them. "Essential fatty acid" defined as fatty acids required for biological processes but does not include the fats that only act as fuel.

6. **Bodybuilding supplements**: Bodybuilding supplements are dietary supplements commonly used by those involved in bodybuilding and athletics. These may be used to replace meals, enhance weight gain, improve weight loss or improve athletic performance. Glutamine, essential fatty acids, meal replacement products, creatine, weight loss products and testosterone boosters are used mostly over all. Supplements are marketed either as single ingredient preparations or in the form of "stacks" - proprietary blends of various supplements marketed as offering synergistic advantages.

7. **Omega 3 Supplements:** In the past 10 years, many Americans have turned to omega-3 fish oil supplements, which have benefits for healthy people and also those with heart disease.Omega3 fish oil contains both docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA). Omega-3 fatty acids are essential nutrients that are important in preventing and managing heart disease. Findings show omega-3 fatty acids may help to:

1. Lower blood pressure
2. Reduce triglycerides
3. Slow the development of plaque in the arteries
4. Reduce the chance of abnormal heart rhythm
5. Reduce the likelihood of heart attack and stroke
6. Lessen the chance of sudden cardiac death in people with heart disease.

8. **Fiber Supplements :**Fiber supplements are the subgroup of functional dietary fibers, and in the United States are defined by the Institute of Medicine (IOM). According to them, functional fiber"consists of isolated, non-digestible carbohydrates which are beneficial physiological effects in humans". Fiber supplements are available in different forms such as powders, tablets, and capsules. It helps in lowering blood cholesterol, eleviating irritable bowel syndrome, reducing the risk of colon cancer, and increasing feelings of satiety.

9. **Minerals Supplements:** Minerals support a wide variety of functions in human body. These are especially helpful when one is on a calorie-restricted diet or because you don’t like eating particular foods containing a specific nutrient. However, consuming too much of some vitamins or minerals can adversely affect well-being of human body. Toxicity can also occur from overconsumption of minerals. Vitamins act as a catalyst in the metabolic reaction that produces energy from the fuel stores and assist in the production of red blood cells, the repair of tissues and protein synthesis. Minerals activate enzymes for energy production through glycolysis and improve immune system. Electrolytes available in minerals affect muscle concentration and iron is important for the formation of haemoglobin.

10. **Calorie Supplements:** High-calorie supplements are beneficial when dealing with some health conditions. AIDS and anorexia can also result in body wasting. Protein, carbohydrates and healthy fats add both nutrients and calories to prevent weight loss during recovery. Picky eaters, rapidly growing children or extreme athletes might also benefit from highcalorie supplements. In the absence of any of these conditions, however, consuming this type of food supplement may merely add extraneous calories to your diet, resulting in accumulation of excess body fat.

Significance of Food Supplements: Supplements improve overall physical performance. These are often taken by athletes to improve their performance. Food supplements can also prevent a variety of diseases and health conditions. For example, pregnant women are advised to take folic acid to prevent birth defects. Sometimes supplements are used in combination with drugs as a method of complementary or alternative treatment for health conditions.

Disadvantages of Food Supplements: Because dietary supplements are not as strictly regulated as drugs, their effectiveness may not be as dependable. Some supplements may be toxic and cause serious side effects when taken in a excess dose. Vitamin A toxicity, for example, can cause liver damage, blurred vision, headaches, bone pain and swelling, drowsiness and nausea. Supplements can cause interaction with medications, which can cause unwanted side effects and decrease the efficacy of the medicine.

SUPPLEMENTATION-

- Food supplements are concentrated sources of nutrients or other substances with a nutritional or physiological effect, with the purpose of supplementing the normal diet.
- Food supplements are highly concentrated vitamins and minerals produced by pharmaceutical manufacturers in the form of capsules, tablets or injections and administered as part of health care or specific nutrition campaigns.
- Food supplements can be in the form of pills, tablets, capsules or liquids in measured doses.
- Supplements may be taken in order to correct nutritional deficiencies or maintain an adequate intake of certain nutrients. However, in some cases an excessive intake of vitamins and minerals can be harmful to health. Therefore maximum levels are necessary to ensure their safe use in food supplements.
- Reaching out to vulnerable groups (particularly children and women of childbearing age) with vitamin and mineral supplements in the form of tablets, capsules and syrups
- The cost can be as low as a few cents per person per year.
- Under Reproductive and Child Health Programme: Young children and adolescent girls are given iron and folic acid.
- Children 6-24 months old are at the greatest risk of the irreversible long term consequences of iron deficiency namely impaired physical and mental development.
- They are given 20mg elemental iron and 100 microgram of folic acid in syrup form. Children below 5 years are given 20mg of elemental iron and 100 microgram of folic acid.
- Adolescent girls on attaining menarche should consume weekly dosage of IFA tablet containing 100 mg elemental iron and 500 microgram of folic acid.
- All pregnant mothers are given 60mg of elemental iron and 500 microgram of folic acid. Low birth weight infants need iron supplementation from the age of 2 months.

II. Food fortification The approach here is to fortify food with essential nutrients. The United Nations' Food and Agriculture Organization recommends that governments in countries with high malnutrition rates consider fortifying food with iodine, iron and vitamin A in particular and that they regulate fortification

III. Dietary diversification

Linking cultivation of a variety of staple foods with a high vitamin and mineral contents to **nutritional education can produce better consumer behavior.** Having a balanced diet involves a number of factors and is a long-term objective, especially by contrast with dietary supplementation. Diversification can take the form of improved agricultural production, development of vegetable plots, a good variety of foodstuffs and sound preparation methods within families, or multisector nutritional advice and training in schools. It can also be delivered through health services, along with food supplementation and fortification and can play a major role in helping to reduce malnutrition.Theapproachhereistofortifyfoodwith essentialnutrients.TheUnitedNations'Foodand AgricultureOrganization recommend that government sin countries with high malnutrition ratesconsiderfortifyingfoodwith iodine; ironandvitaminUnparticular andthattheyregulate fortification.
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Mineral Fortification

- Regulate body processes
- Give structure to things in the body
- No calories (energy)
- Cannot be destroyed by heat

Advantages

- Potentially rapid improvements in micronutrient status of population.
- Reasonable cost, especially with existing technology and local distribution networks.
- Requires no changes in existing food patterns or in individual compliance.
- Fortified food consumed in adequate amounts by target population.
- Fortificants that are stable and well absorbed, but do not affect sensory properties of foods.
- Preferably, centrally processed food vehicles.
- Government and food industry partnership.

Why do we need fortified food?
- Busy lifestyles and the need for on-the-go foods.
- Bad eating habits.
- More stress and stress related diseases.
- Less food preparation time.
- Ageing population and age related diseases.
- Rising obesity and obesity related diseases.
- Why do we need fortified food.

Examples of mineral fortified foods:
- Milk with Vitamin D
- Salt with Iodine
- Fruit juice with Calcium
- Water or toothpaste with fluoride
- Flour with Folic Acid
- Bread with Niacin
- Orange sweet potatoes with β-carotene/pro-vitamin A
- ('Golden') Rice with β-carotene/pro-vitamin A, iron, zinc
- 'Orange' Maize with β-carotene/pro-vitamin A
- Bananas with β-carotene/pro-vitamin A
- Beans with iron
- Cassava with β-carotene/pro-vitamin A
- Pearl millet with iron
- Wheat with zinc

Three types of Mineral fortification are in place:
Conventional fortification
- Staple foods (flour, sugar, milk, oil, rice)
- Dairy (milk, yoghurt)
- Spreads (margarine)
- Condiments (salt)

Home fortification
- Crushable/soluble tablets
- Powder
- Spreads

Bio-fortification
- Agricultural products ○ (Rice, maize, sweet potato,…)

- **Salt iodization introduced** in early 1920s in both Switzerland and USA; now available in most countries
- **From early 1940s, fortification of cereal products** with thiamine, riboflavin and niacin became common practice
- **Margarine fortified** with vitamin A in Denmark
- **Milk fortified** with vitamin D in USA
- **Foods for young children fortified** with iron - substantially reduced risk of iron-deficiency anemia in this age group
- **Folic acid fortification of wheat** adopted by Canada, USA and Latin America
- **In the less industrialized countries**, fortification is an increasingly attractive option
- **Success of programs to fortify sugar** with vitamin A in Central America - vitamin A deficiency reduced considerably; similar initiatives in sub-Saharan Africa.

Mass fortification
As indicated above, mass fortification is the term used to describe the additionof one or more micronutrients to foods commonly consumed by the general public, such as cereals, condiments and milk. It is usually instigated, mandatedand

regulated by the government sector.Mass fortification is generally the best option when the majority of the populationhas an unacceptable risk, in terms of public health, of being or becomingdeficient in specific micronutrients. In some situations, deficiency may be demonstrable, as evidenced by unacceptably low intakes and/or biochemical signs of deficiency.

Targeted fortification

In targeted food fortification programmes, foods aimed at specific subgroups of the population are fortified, thereby increasing the intake of that particular group might be impractical. Under such circumstances, one option would be, if feasible, to allow small mills to fortify their product on a voluntary basis but following specified regulations. rather than that of the population as a whole. Examples include complementary foods for infants and young children, foods developed for school feeding programmes, special biscuits for children and pregnant women, and rations (blended foods) for emergency feeding and displaced persons are managed by the World Food Programme (WFP) and guidelines covering their fortification (including wheat soy blends and corn soy blends) are already available.

Market-driven fortification

The term “market-driven fortification” is applied to situations whereby a food manufacturer takes a business-oriented initiative to add specific amounts of one or more micronutrients to processed foods.

Adequate mineral intake is a crucial part of a healthy diet for all—it supports appropriate growth and development and provides protection against childhood conditions like anemia and helps to prevent future adult diseases such as osteoporosis. Challenges in performing and interpreting studies in infants and children have hampered the accurate assessment of their mineral utilization. Many of the most powerful techniques used in adults, such as radioisotope testing, are not appropriate for use in children. In recent years, advanced mineral stable-isotope techniques have been developed to fill this gap. Pediatric applications include studies of calcium absorption and kinetics during puberty and evaluation of the calcium-iron interaction in infants and toddlers. The effects of genetics in determining calcium absorption and bone turnover may become an important research area. In the past, the cost and difficulties in obtaining isotopes have limited such research. This situation has improved considerably, although relatively few nutrition research laboratories are prepared to perform sample analyses.

Stable Isotopes In Nutritional Studies

Interest is increasing in the role of mineral nutrition in the health care of children. Mineral nutrition not only meets children's growth and developmental needs, but also may limit or prevent disease processes (eg. diarrhea) and protect against future diseases (eg, adult osteoporosis). Children are a particularly challenging group in which to perform nutritional research, not only because of their rapid growth, but also because of the difficulties inherent in dietary regulation and sample collection in children. Use of stable isotopes offers a unique opportunity to meet the need for evidence-based dietary guidelines. Stable-isotope studies may also provide physiologic information regarding nutrient metabolism that is otherwise unobtainable in children.

There are numerous methods for evaluating mineral requirements in children. One important approach to assessing requirements is to determine the amount of minerals absorbed and retained by children consuming diets providing various intakes. This can be done by several methods. These include mass-balance measurements, radioactive mineral administration, and stable-isotope methods.

Stable isotopes are very useful tools which are used extensively in scientific research. Within the field of nutritional studies stable isotopes are used for studying the flow of nutrients through the human body. Since they are safe and non-radioactive they can even be used in infants and pregnant women.

Compounds containing stable isotopes can be identified and measured using the molecular weight of the compound. This is because it will differ from that of the original compound. Using an instrument called a mass spectrometer, researchers can use this weight difference to trace the stable isotopes as they travel through the body and appear in blood, urine, breath, and stool samples.

The first paper published that described the use of a stable isotope tracer in a human metabolic study was in 1963. Today, there are four commonly studied isotopes used in nutrition studies, which include calcium, iron, magnesium and zinc.

CALCIUM ISOTOPES

Calcium isotopes are used at length in clinical research studies. Calcium has six stable isotopes, which include ^{40}Ca, ^{42}Ca, ^{43}Ca, ^{44}Ca, ^{46}Ca and ^{48}Ca. They are used to measure calcium absorption mainly in women and children. In adults, calcium deficiency is strongly related to increasing severity of osteoporosis. In children, calcium deficiency is primarily related to the development of rickets. (S.A. Abrams and W.W. Wong, Stable Isotopes in Human Nutrition, 2003).

The most abundant calcium isotope, ^{40}Ca (96.97% natural abundance), is rarely used in nutrition research, although very highly enriched (>99.9%) ^{40}Ca can be administered over time to wash out the lower-abundance isotopes. The large quantity of ^{40}Ca needed for this purpose makes this relatively impractical. The existence of a very-low-natural-abundance isotope, ^{46}Ca (0.003% natural abundance), and 4 other low-abundance isotopes makes calcium a favorable mineral for tracer studies.

IRON ISOTOPES

There are four stable Iron Isotopes: ^{54}Fe, ^{56}Fe, ^{57}Fe and ^{58}Fe. The two most commonly used isotopes in nutritional studies are ^{57}Fe and ^{58}Fe. Iron stable isotopes are usually provided as iron metal and are converted to ferrous sulfate before oral administration. Both the supply and cost of these isotopes have remained relatively constant or have decreased in recent years. Because dosing of iron stable isotopes is dependent on enriching the circulating body iron pool. The dose administered is usually dependent on the subject's weight, and increases in proportion to weight and hemoglobin concentration. One study, conducted by the University of Iowa and the University of Texas (Samuel J. Fomon et al., January 2003) involved the use of ^{58}Fe to study iron-loss by human adolescents. The investigators were able to estimate inevitable iron loss by adolescents because total body iron of the adolescents had been enriched with the stable isotope, ^{58}Fe, as the result of earlier studies of iron absorption. At the conclusion of this study, they were able to estimate the requirement for absorbed iron.

MAGNESIUM ISOTOPES

The measurement of magnesium absorption, endogenous excretion, and kinetics with stable isotopes in children is a significant methodological challenge. The difficulty lies in the fact that, unlike calcium, zinc, and iron, which have ≥4 naturally occurring stable isotopes, there are only two stable Magnesium Isotopes: ^{25}Mg and ^{26}Mg are regularly used in studies. None of the 2 isotopes of magnesium are of low abundance (ie, <5%). Therefore, to achieve measurable enrichment of a serum or urine specimen, a relatively large dose of isotope needs to be given. This dose represents a significant fraction of the exchangeable magnesium pool and therefore may not function as a true tracer. Furthermore, although magnesium isotopes are readily available for purchase, the large doses required make these studies somewhat expensive to perform. It is known that magnesium is important in bone and muscle function. Deficiency conditions have been associated with disorders including bone loss, diabetes and neurological impairment (Rude, 1998).

ZINC ISOTOPES

There has been increased interest in zinc in pediatrics because of recent studies suggesting an association between low zinc status and infections, especially diarrheal illnesses and respiratory infections. The possibility of using supplemental zinc to decrease the consequences of these infections or to enhance growth in children, especially in underdeveloped nations, is an important area for ongoing research.
There are five stable Zinc Isotopes: ^{64}Zn, ^{66}Zn, ^{67}Zn, ^{68}Zn and ^{70}Zn. The three most commonly used isotopes in nutritional studies are ^{67}Zn, ^{68}Zn and ^{70}Zn. There are many studies being conducted in areas including the deficiency of zinc in children in developing countries and absorption rates of zinc. A deficiency of zinc can cause poor growth, reduced resistance to infections, and life-threatening bouts of diarrhea and pneumonia.

Conclusion:

Nutritional problems underlying these trends (particularly in developing countries) are generally not related to an absolute deficiency of food — to overt hunger. In most cases, they are caused by insufficient quality of food, or lack of variety, leading to deficiencies of vitamins and essential minerals. Because many effects are not immediately obvious to the naked eye, the World Health Organization (WHO) has coined the term "hidden hunger" to describe these problems. In a number of ways, the work of the IAEA is contributing to efforts directed at overcoming hidden hunger and other nutrition

problems. The rationale for the IAEA's involvement is twofold. First, adequate nutrition is an essential component of any strategy for improving health, and the IAEA's Statute specifically identifies "enlarging the contribution of atomic energy to peace, health and prosperity" as the major objective of programmes.

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