Fortification and the Changing Role of Food

Micronutrients (vitamins and minerals) which help the body use macronutrients are vital to proper physiological function (Lukaski, 2004). Micronutrients are consumed on a much smaller scale than macronutrients (Lukaski, 2004). In today's general Westerner's diet, it is unlikely that all the necessary daily micronutrient requirements are met via ingestion of foods--even for a healthy person with the perfect macronutrient diet. Emerging deficiencies may be attributed to the modern Western lifestyle, the nutritive value of food and fortification, and the metabolic pathway of micronutrients.

Food has become less "functional food" and more for "pleasure"--"taste" preferences over function. The modern Western lifestyle favors convenient, economical, time-saving, refined and processed food choices which have led to new "emergent deficiencies" such as folate and neural tube defects, zinc and child growth, selenium and cancer which replace "deficiences of the historical past" such as goiter, rickets, beriberi and pellagra (de Lourdes Samaniego-Vaesken, Alonso-Aperte, & Varela-Moreiras, 2012). Additionally, the culture of food in today's Western lifestyle has unfortunately cultivated a propensity towards obesity, metabolic syndrome, atherosclerosis, diabetes, cancer and a host of other health concerns (de Lourdes Samaniego-Vaesken et al., 2012).

Back in the 1920's the United States government via public health recognized that nutrition from food/food products was not enough. Hence, the food fortification program (spreading to over 67 countries internationally as well) was born starting with iodine added to salt to prevent goiter followed by milk fortified with vitamin D, and flour with vitamin B (de Lourdes Samaniego-Vaesken et al., 2012). Food fortification started as a concern and service to public health. However the demographics have changed so much over the years that several issues arise including identification of which demographic actually needs "fortification" (as many subgroups have emerged with different needs); is fortification still necessary or is there a danger of "over-fortification" when consumers ingest several items that have been "fortified" (would they be over-fortifying themselves unknowingly by their food choices); and how should food fortification continue to be advised, monitored, and regulated beyond the current "voluntary decision to fortify" (by food manufacturers) both nationally and internationally (de Lourdes Samaniego-Vaesken et al., 2012). Another concern is the lack of accurate up-to-date nutrient information about fortified, processed, and engineered foods in food composition databases--essentially you really do not know what you are eating and how foods react together in vivo (de Lourdes Samaniego-Vaesken et al., 2012; McCormick, 2010).

While food has become more abundant over the years, the nutritive value of food has declined due to refining/processing, farming/harvesting techniques, and food engineering. Food fortification ("enrichment" used interchangeably) as defined by the Codex Alimentarius of the Food and Agriculture Organization (FAO) is the "addition of one or more essential nutrients to a food whether or not it is normally contained in the food for the purpose of preventing or correcting a demonstrated deficiency of one or more nutrients in the population or specific population groups" (de Lourdes Samaniego-Vaesken et al., 2012; Dwyer et al., 2014).

The US Food and Drug Administration (FDA)'s 1980 "Nutritional Quality of Foods; Addition of Nutrients" policy outlined how nutrients should be restored to food to bring the nutritive value of food back up to before it was processed, stored/ packaged, and handled (Dwyer et al., 2014). Nutrients must be pre-approved food additives, and the FDA maintains a list of food that can and can not be fortified, and the "rules" around fortification (Dwyer et al., 2014). Fresh food such as fish, meat, poultry, and produce should not be enriched/fortified as well as sugars, candies, carbonated beverages (Dwyer et al., 2014). For example, Folic acid and vitamin D are limited to certain foods, and vitamin A can be added without any constraints (Dwyer et al., 2014). Margarine must be fortified with vitamin A and may contain vitamin D (Dwyer et al., 2014).

The FDA's "rules" of food fortification/enrichment are based on models of dietary intakes of the population. National surveys have revealed that enriched grains and ready-to-eat cereals contribute significantly to the intake of some nutrients (Dwyer et al., 2014). Surveys (NHANES 2005-2008) showed that a significant American population did not meet the estimated average requirement (EAR) of one or more nutrients even when dietary supplements were included in the poll (Dwyer et al., 2014). Macro- and micro-nutrients are needed on a steady daily basis, and it is very questionable even with fortification and supplementation if people are truly getting the amounts that they need without a major lifestyle makeover or intervention.

Finally, emerging deficiencies may also be attributed to the availability and lesser known metabolic pathway of micronutrient. Stops along the nutrient pathway include liberation, absorption, distribution, metabolism, and elimination (LADME) (Fernández-García, Carvajal-Lérida, & Pérez-Gálvez, 2009; Rein et al., 2013).

Bioaccessibility is the fraction of the bioactive compound that is released/liberated from the food matrix (foods that are co-eaten) as the bolus finishes travelling the digestive path and nutrients are ready for absorption in the intestines (Fernández-García et al., 2009; Rein et al., 2013). Bioaccessibility depends on the components of the food matrix, pH, temperature (nutrients are temperature sensitive and many are rendered ineffective from cooking/food-processing), and other physiochemical properties (such as reactivity to stomach acid, enzymes, flora) (Rein et al., 2013). Some components are less bioaccessible such as plant-based food due to the robustness of their cell walls and resistance to break-down (Rein et al., 2013).

Bioavailability refers to the portion of the ingested bioactive compound (nutrient) that is available (after being made bioaccessible) for physiologic functions and for storage; it is the portion of the food's nutrients that the body can actually use (i.e. absorbed and released into the blood stream) (Fernández-García et al., 2009; Gregory, 2012). Factors affecting absorption are solubility (water or fat soluable), interaction with other bioactives, molecular transformations, cellular transporters (bind to the bioactive and transport them across membranes, availability of transporters are often the limiting factor), metabolism, and interactions with the gastrointestinal flora (which are different for different people) (Rein et al., 2013).

Bioactivity of a compound/nutrient refers to how that nutrient is transported/delivered to the target tissues or how the nutrient reaches its destination (places in the body where it is

needed), interactions with other molecules, and how it undergoes transformation or metabolism (Fernández-García et al., 2009).

After the digestion journey and relative to the amount of macronutrients ingested and available, the amount of micronutrients accessed is much smaller--on the order of milligrams and micrograms. Whether a person intends to supplement or not, the chances are that one is already receiving "secondary/indirect supplementation" through fortified foods. More than likely a person would probably benefit from some minimal supplementation by advice of their doctor (and registered nutritionist) after a blood/lipid panel. Eat what you can in whole foods/ingredients. Supplement what you need determined by sound medical advice. Each person is unique and has an unique metabolism/digestion; there is no "formula" method that will fit everyone's needs with regards to nutrition and supplementation.

References

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