

## Fortified Foods with Mineral Elements - Conceptual and Applicative Data

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### ABSTRACT

In the last decade food business operators are selling more and more foods to which vitamins and minerals were added. The reason is to restore their content where this has been reduced during processing, storage or handling procedures. Beside the mentioned micronutrients, other ingredients might be used in food manufacturing, too. Among such substances one can mention : amino acids, essential fatty acids, fibre, various plants and herbal extracts. At the Community level the Regulation (EC) 1925/2006 harmonises the effective functioning of the internal market as regards the addition of vitamins and minerals and certain other substances to foods. For an efficient monitoring of foods to which vitamins and minerals and other substances have been added the manufacturer or the person placing such foods on the market must notify the competent authority of that placing on the market or on the withdrawal of the product from the market.

**Key words:** fortified foods - mineral elements

### INTRODUCTION

During processing, storage and handling processes the final food product may loose micronutrients, mainly vitamins and minerals. Also, there are regions where the soil is spoiled in some minerals and the resulted crops and vegetables will be also poor in essentials minerals, necessary for the optimal functioning of the organisms. Therefore food business operators started to add some vitamins, minerals and other substances to some foods.

Food or foodstuffs, according to the definition given in the Regulation 178/2002, means „any substance or product, whether processed, partially processed or unprocessed, intended to be, or reasonably expected to be ingested by humans”. ”Food includes drink, chewing gum and any substance, including water, intentionally incorporated into the food during its manufacture, preparation or treatment”.

The European Community Regulation 1925/2006 establishes the same rules for all Member States regarding fortified foods.

## **1. MINERAL ELEMENTS IN FOODS - OVERVIEW**

From nutritional point of view the minerals (beside vitamins) are included in the group of micronutrients. Minerals are essential nutrients to life, are needed in small amounts and participate in numerous catabolic and anabolic reactions in various biochemical pathways. Beside other nutrients the mineral compounds participate in physiological processes which assure the health maintenance. For the human organism there are essential about twenty eight elements, e.g. Ca, Mg, Na, K, Zn, Fe, Cu, Se, I etc. (Berdanier, 1998; Richardson, 2007)

Mineral micronutrients are generally divided in two sub-categories accordingly to their chemical characteristics: the micronutrients with cationic nature (metals) and micronutrients with anionic nature (non-metals). Also, taking in account the amount of this elements that is found in the organism, the mineral nutrients can be classified in macroelements, e.g.: Na, K, Ca, Mg, P, Cl etc. and trace elements, e.g.: Zn, Fe, Cu, I, Se.

They are often found as cofactors in enzymes, e.g.: Zn<sup>2+</sup> in alcohol dehydrogenase; Mn<sup>2+</sup> in phosphotransferase; Fe<sup>2+</sup> in the lysosomal myeloperoxidase; selenium in the metalloenzyme glutathione peroxidase etc. (Champe and Harvey, 1987; Chaney, 1992). Minerals can be present also in the composition of some hormones, e.g.: iodine in thyroid hormones ; in certain amino acids, e.g.: selenomethionine; in hemoglobin or myoglobin.

Deficiency of minerals and especially of trace elements in food are actually more likely to occur than is vitamin deficiency. Because of differing geologic conditions minerals and trace elements may scarce in the soil of certain region and rich in those of other regions (O'Dell and Sunde, 1997; Gârban and Gârban, 2003). The insufficiency or lack of one or more minerals leads to dysmineraloses.

## **2. FORTIFIED FOODS : FOOD CATEGORIES, LEGISLATION**

According to the European Food Safety Authority (EFSA) and Codex Alimentarius Commission various food categories can be fortified. Regulation (EC) No 1925/2006 of the European Parliament and of the Council establishes the rules for the addition of vitamins and minerals to foods and the use of certain other substances or ingredients in foods. In Annexes I and II of that Regulation are the lists of vitamins and minerals, and for each of them the forms, that may be added to food.

In the meantime EFSA evaluated new vitamin and mineral forms. The substances which have received favourable scientific opinion were added to the lists with the Commission Regulation (EC) No 1170/2009. In Annex III of this Regulation the new list of „Vitamin formulations and mineral substances which may be added to foods” can be find.

In case of fortified foods it is also necessary to have in view the Commission Directive 2008/100/EC amending Council Directive 90/496/EEC on nutrition labeling for foodstuffs as regards recommended daily allowances, energy conversion factors and definitions, because the addition of a vitamin or a mineral to a food shall result in the presence of that vitamin or mineral in the food in at least a significant amount where this is defined according to the Annex to Directive 90/496/EEC.

Various diseases can reduce the mineral nutrients intake and especially those that interfere with the ingestion, digestion, absorption and requirement of nutrients: celiac disease, Crohn disease, irritable bowel syndrome, lactose intolerance, bacterial, viral and parasitic infections (Chaney, 1982; Shrimpton, 1997).

Evidence from recent studies revealed that mineral trace elements supplementation may help to prevent various forms of cancer, heart disease and some other degenerative processes.

A way to increase the mineral micronutrient levels from diet is food fortification by adding such nutrients during the food processing or the consumption of food supplements with specific minerals.

### 3. MINERAL ELEMENTS IN FORTIFIED FOODS

Mineral micronutrients can be found in various chemical forms with different levels of absorption at the level of gastrointestinal tract and with various degrees of bioavailability. Therefore the regulatory institutions must establish which forms are safer and have a higher bioavailability. Recently the European Commission had issued Regulation 1170/2009 amending Directive 2002/46/EC and Regulation 1925/2006/EC regarding the lists of vitamins and minerals and their forms that can be added to foods, including food supplements. The *nutritional reference value* (NRV) for minerals and vitamins are specified in Regulation 1169/2011.

#### 3.1. Macro- and micronutrients with cationic character

Regulation EC 1170/2009 of the European Parliament and the Council establishes the nutrients and their chemical forms which may be added to foods. Detailed data referring to the chemical forms of micronutrients with cationic character are presented in table 1.

**Table 1.** Chemical formulations of the cationic mineral substances which may be added to foods

Micronutrient	Measure unit	NRV	Chemical formulations
Potassium	mg	2000	bicarbonate ; carbonate ; chloride ; citrate ; gluconate ; glycerophosphate ; lactate ; hydroxide ; salts of orthophosphoric acid
Calcium	mg	800	carbonate; chloride; citrate malate; salts of citric acid; gluconate; glycerophosphate; lactate; salts of orthophosphoric acid ; hydroxide ; malate ; oxide ; sulphate
Magnesium	mg	375	acetate; carbonate ; chloride ; salts of citric acid ; gluconate ; glycerophosphate ; salts of orthophosphoric acid; lactate; hydroxide; oxide ; magnesium potassium citrate; sulphate
Iron	mg	14	ferrous bisglycinate; ferrous carbonate; ferrous citrate; ferric ammonium citrate; ferrous gluconate; ferrous fumarate ; ferric sodium diphosphate ; ferrous lactate; ferrous sulphate; ferric diphosphate (ferric pyrophosphate) ; ferric saccharate ; elemental iron (carbonyl + electrolytic + hydrogen reduced)
Zinc	mg	10	acetate ; bisglycinate ; chloride ; citrate ; gluconate ; lactate ; oxide ; carbonate ; sulphate
Manganese	mg	2	carbonate ; chloride ; citrate ; gluconate ; glycerophosphate ; sulphate
Copper	mg	1	cupric (Cu II) salts: cupric carbonate ; cupric citrate ; cupric gluconate ; cupric sulphate ; copper lysine complex
Chromium	mg	40	chromium (III) chloride and its hexahydrate ; chromium (III) sulphate and its hexahydrate
Molybdenum	µg	50	ammonium molybdate (molybdenum (VI); sodium molybdate (molybdenum (VI)

Various organisms such as the Scientific Committee on Food (SCF), the European Food Safety Authority (EFSA a.o. are involved in the establishment of the tolerable upper intake of minerals. According to SCF and EFSA the tolerable upper intake levels for some of the cationic minerals are : Ca – 2500 mg, Mg – 250 mg, Cu – 5 mg, Zn – 25 mg

### 3.2 Micronutrients with anionic character

The micronutrients with anion specificity (i.e. non-metals) which may be added to foods are, according to the Regulation EC 1170/2009 of the European Parliament and the Council : iodine, selenium, fluoride and boron.

The chemical formulations of micronutrients with anionic character as well as their NRV are given in table 2.

**Table 2.** Chemical formulations of the anionic mineral substances which may be added to foods

Micronutrient	Measure unit	NRV	Chemical formulations
Fluoride	mg	3.5	sodium fluoride ; potassium fluoride
Iodine	µg	150	sodium iodide ; sodium iodate ; potassium iodide ; potassium iodate
Selenium	µg	55	selenium enriched yeast ; sodium selenate ; sodium hydrogen selenite ; sodium selenite
Boron	mg	NE*	boric acid ; sodium borate

\*NE – not established

From the anionic minerals used in fortified foods selenium and iodine are more often found. Less often is used boron. In the case of anionic nutrients the tolerable upper intake levels, according to Scientific Committee on Food (SCF) and the European Food Safety Authority (EFSA) are: F – 7 mg, I – 600 µg, Se – 300 µg, B – 10 mg/day.

The presence of too small and insignificant amounts of micronutrients in foods would not offer any benefit to consumers and would be misleading. Thus, in order to be allowed to be declared in nutrition labelling, vitamins and minerals added to foods should be at least a significant amount, i.e. 15% of the RDA per 100g or 100ml (Annex of Directive 90/496/EEC).

### CONCLUSIVE DATA

1. In case of fortified foods an important aspect is related to the source compounds of minerals, namely the chemical formulations which can be used in their manufacture.
3. Mostly the following food categories are fortified : beverages excluding dairy products; dairy products and analogues; cereals and cereal products; confectionary; fats and oils, and fat emulsions.

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