

## Water as a New Vehicle for Nutrition

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### Abstract

The beneficial effects of beverages with added micronutrients on human health are being increasingly promoted by health professionals. Nutrients fortified beverages available in the market today, are usually in the form of flavored water, fortified juices, sweetened beverages having high calories; however with an increase in the consumer awareness about calories, there is also a demand for the nutrients fortified mineral water without sugar and flavors, so as to get the taste of original water. And, owing to health considerations, from the perspective of obesity in sweetened beverages and economic reasons for the developing countries, alternative raw materials for nutrient fortification need to be searched. Considering the above mentioned facts, water may be potential substrate and cheapest source, where the fortified nutrients will make a mark and healthy alternative for obesity and nutrient deficiency consumers. This review aims at highlighting the need for nutrients fortified mineral water.

**Keywords:** Micronutrients; Fortification; Fortified mineral water

### Introduction

Rising medical costs are the prime factor forcing people to find cheaper and effective means of protecting their health. This fact has led to an increase in consumer's interest in functional foods. Water's importance for the prevention of nutrition-related non-communicable diseases has received more attention recently because of the shift toward consumption of large proportions of fluids as caloric beverages. Vitamins water allows the body to absorb vitamins at a faster rate than can be delivered with traditional food products. Some of these can be low calorie drinks loaded with micronutrients. 'Micronutrients' are the nutrients required by humans in small quantities to achieve physiological functions. The term is collectively applied to essential vitamins and minerals. These substances enable the body to produce enzymes, hormones and other substances essential for proper growth and development.

Water is an essential nutrient. Without it human life cannot survive. Water deprivation kills faster than lack of any other nutrient [1]. Water is considered to be a major nutrient [2].

Bottled water is the second largest commercial beverage category by volume (9107 Million Gallons) in the United States followed by China, Mexico, Brazil, Indonesia, Thailand, Italy, Germany, France and Spain (Beverage Marketing Corporation 2012). 61,370 Million Gallons of bottled water consumption and 5.5% Compound annual growth rate were achieved by the growth of the global market during the period of five year (2006-11) (International Bottled Water Association statistics 2011).

All bottled water production must comply with food safety regulations and is also guided by industry good practice and guidelines. The water is monitored in all production steps, according to control plans derived from a compulsory Hazard Analysis and Control of Critical Points approach (European Federation of Bottled Waters). Different forms of water such as tap water and packaged bottled water vary in calcium, magnesium, TDS etc. One of the study shows that filters removes a significant amount of minerals including calcium from the water [3]. Therefore, additionally fortifying packaged bottled water would be beneficial in case of mineral bioavailability.

Malnutrition and infection in early life increase the risk of chronic non communicable diseases in later life, and in adult life, combinations

of major non communicable diseases and infections, such as diabetes and tuberculosis, can interact adversely [4]. One study shows that diseases in children and malnutrition were found in urban slum dwellers in southern India [5]. Diarrhea and pneumonia impair children's growth and that underlying malnutrition is a major risk factor for these. Diarrhea may predispose to pneumonia in undernourished children [6]. In one review they mentioned as illness-related malnutrition has been reported in 10% to 55% of ill people in hospital and the community in areas of food sufficiency [7].

In 1912, early in the twentieth century, scientists were able to qualitatively detect small amounts of several elements in living organisms. At the time, these elements were often described as being present in «traces» or «trace amounts.» This apparently led to the term «trace elements,» which today is usually defined as mineral elements that occur in living systems in micrograms per gram of body weight or less. The League of Nations began to establish guidelines and principles for conducting dietary surveys in different populations worldwide. The survey methods included assessment for various micronutrient deficiencies. Thereby an idea was developed in the late 1930s and during World War II in Great Britain and the United States; to fortify foods with different micronutrients [8]. This gave rise to the idea of externally adding these nutrients to fortify foods.

Fortification 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 demonstrated deficiency of one or more nutrients.

Evolution of fortified water started in 7000 years ago; the grape wine was mixed with water. This wine helped to kill the microorganisms

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present in the water, enhanced its shelf life and also enriched the water with nutrients from grapes. It also had medicinal properties to relief pain, digestive supplement etc. In 18<sup>th</sup> century, Lime and Lemon juices blended with water used to cure scurvy disease (Vitamin C deficiency) in British sailors on long journey [9].

All these inspired the development of fortified water. Presently in the market, many manufacturers of fortified water make claims are made about weight loss, strengthen the immunity, improve memory etc. are seen in the market.

### Water as a Vehicle of Fortification

Vitamins water allows the body to absorb vitamins at a faster rate than can be delivered with traditional food products. Henceforth, the concept of fortification of micronutrients in water (as a cheapest source and easily available to all categories of people in developing countries) can really become an innovative product. Vitamin Fortified mineral water is a shelf stable, ready to use, safe drinking water consumed directly, tube feedings or in the preparation/reconstitution of foods/beverages [10].

### Boons of Fortified Water

Water is an essential component for chemical reactions in the body. It is useful to give energy from foods, in the digestive process, for the transport of nutrients as a media, removal of waste products from the body. It also helps in regulating the body temperature by producing sweating. Failure to take enough fluids leads to dehydration. Hydration can be more effective by fortified or enhanced water. Fortified water enhanced with electrolytes such as potassium and sodium chloride helps to replenish those electrolytes lost during physical activity [9].

In 1992, At International conference on nutrition (ICN), recommended for the alleviation of micronutrient malnutrition by fortification of water with micronutrients. Research shows that the use of drinking water as a vehicle for nutrient fortification is a highly effective approach to combat deficiency diseases; moreover it is the cheapest source. An example of this addition of fluoride, iodine and iron to public drinking water supplies to improve dental health and iodine deficiency and anemia respectively [9].

Fortified micronutrients water is a water with added delivery system such as premixes/encapsulated particles of different sizes, materials, non-visible, serving one or more important functions like no off taste, odor masking, controlled release applications, minimized interactions, improved stable, oxidative and shelf life; bio-availability of actives, avoid hygroscopicity. Composition ensures hydration, having the ability to target specific health goals i.e. Meeting vitamin deficiency, weight loss, diabetes, cholesterol/heart, osteoporosis, gastrointestinal disorders, cancer, stress, stimulant etc.

### Bioavailability of Minerals in Water

Magnesium is an essential cation for more than 300 enzymes in our body. It is also a cofactor for ATP metabolism. One study suggests that adding magnesium to the water supplies of large areas than in food [11].

This paper aims to discuss fortification of water in terms of its techno-economic feasibility. This is a unique approach of fortifying a nutrient (water) with other nutrient as water is now nutrient in itself with its innumerable functionality in human body such as basis of blood, digestive juices, urine and perspiration. In Exercise Physiology, Water plays an important role in two aspects, such as Heat Dissipation and Physiological Homeostasis. As the body can't store water, we need

fresh supplies every day to make up for losses from the lungs, skin, urine and faeces.

### Trends in Water Beverages

By FDA standards, products marketed as bottled or packaged drinking water should contain no added ingredients except for fluoride and antibacterial agents within the limits set by the FDA. But many of the products in the market with sweeteners, flavorings, herbal supplements, caffeine, antioxidants, electrolytes, vitamins and minerals etc. fall into a category of drinks called water beverages.

### Water Based Drinks

Consumers have been deriving health benefits from fruit juices were their primary objective to get vitamins and minerals. But however, consumers find “no- calorie” options (enhanced water) and lifestyle energetic beverages (Energy drinks). These aspects of some consumers see juice as an occasional drink. On the other way, juice companies are trying to change the position to functional juice through fortification with functional ingredients. Many Ready to serve beverages excluding milk based to some extent are manifestation of water in different fortified form. Products like Ready to serve juices, nectars, flavored drinks etc. are fortified water with fruit juice of 10-20% to enhance water as per different regulatory provisions across the world.

Glacéau vitamin water and extensions alone contributed to 14% of the total functional beverage growth during 2004-06. Manufacturers are launching products with claims beyond vitamin hydration. For example, vital lifestyle water offers the brand vitality, which claimed to improve the appearance of skin with ingredients like lime, cucumber, white tea and aloe Vera. Kellogg launched product Special K20 protein water targeting a different wellness goal, in 2006. It is positioned as nutritious “shape management” which helps consumer to lose weight [12].

Soft drinks are also moving into the functional realm for consumer's concern for no-calories concept. Manufacturers have launched products to attract consumers through “good-for-you” and “functional” positioning. In 2007, PepsiCo launched Diet Pepsi Max with ginseng—a stress reducer and nourishing stimulant. The product is targeted of age 25–34. In 2007, Coca-Cola introduced Diet Coke Plus. The sugar-free product contains niacin, vitamins B-6 and B-12, and minerals, including magnesium and zinc. It is the first nutrient enhanced soft drink brand offered by a major company.

### Why Micronutrients Fortified Water?

During the last decade, consumers' approach to healthy foods has changed dramatically. Everyone needs to drink water as a daily essential component of diet, then why not water to survive and nutrients to function? Vitamin Fortified mineral water is a shelf stable, ready to use, safe drinking water consumed directly, tube feedings or in the preparation/reconstitution of foods/beverages. Fruit based or foods based functional foods/beverages adds more calories but micronutrients fortified water may contain 0-10 calories per serving, useful for weight loss with proper delivery of nutrients. Moreover, all functional foods may not be liked by all ages/categories of people; whereas water is an important component of life and hence, consumed by all; in addition to it, it also contains nutrients in it. Some functional foods are over processed/cooked, some contains allergens; not suitable for all categories of people, so all these can be overcome by fortifying in water.

People like picking up a bottle of fortified water because it may contain electrolytes that prove beneficial for people who are suffering from flu or who are involved in an intense physical activity and tough workouts.

It might be possible that minerals were not lost during processing, but combined with co-nutrients or non-food components. They may become unavailable for digestion due to these interactions. The mineral studies were mostly concerned with the losses of Ca, Zn and Fe during processing like soaking, milling, heat treatments, boiling/cooking, blanching, steaming, pasteurization, sterilization, canning, baking, frying, drying, freezing, fermentation, germination, extrusion, packaging, storage, home preparation [13]. As micronutrients fortified water involves no heat treatment and all the above mentioned few treatments and it undergoes cold fill process. Hence, Nutrients are not lost and can be retained in mineral water. Study suggests that high calcium mineral waters could provide useful quantities of bioavailable calcium [14].

### Bioavailability based Micronutrient Choices

The beneficial effects of water with added vitamins and minerals on human health, and in particular on malnutrition and other high risk populations, are being increasingly promoted by Industrial research experts and health professionals. It has been reported that micronutrients can play an important role in maintenance of tissue function and also for to sustain metabolism in terms of metabolic effect as well as antioxidant effect and also observed that supplementation of micronutrients leading to a reduction in the incidence of infections in the elderly population, in coronary artery disease, or in malignant disease [15,16]. However, some health benefits, e.g. Fortified mineral water improved folate status and reduced plasma homocysteine concentrations in the pregnant women [17]. The major nutrient deficiencies occurring in the world wide over 90% of the worlds stunted children are there in 34 countries [18].

Mineral water fortified with vitamins and folic acid reduces plasma homocysteine levels, which is a risk factor for cardiovascular disease. One of the Scientists from Finland reported that water fortified with Vitamin B6, B12 and D as wells as the calcium raised the folate levels and reduce the homocysteine concentration in people subject to folate deficiency. Calcium fortified in mineral water is bioavailable [19]. Magnesium and bicarbonate content of the mineral water resulted in favorable changes in urinary pH, citrate excretion and magnesium, inhibitors of calcium oxalate stone formation and counterbalancing the increased calcium excretion [19].

Both lipid-soluble (e.g. vitamin A,  $\beta$ -carotene, vitamins D,E and K) and water-soluble (e.g. ascorbic acid) vitamins can be encapsulated using various technologies. The most common reason for encapsulating these ingredients is to extend the shelf-life and protecting them against oxidation [20]. Lipid-soluble vitamins such as vitamin A,  $\beta$ -carotene and vitamins D, E or K are much easier to encapsulate than water-soluble ingredients. A commonly-used procedure is spray-drying of emulsions [21].

Oxidation of ascorbic acid is a free radical-mediated process, which results in a series of reactive intermediates [22]. In beverages, the best way to protect water soluble ingredients by encapsulation in liposomes. Liposomes are single or multilayered vesicles of phospholipids containing either aqueous-based or lipophilic compounds [23].

### Research Scope and Future Challenges

Further research on the industrial manufacturer side, is to work on

water fortified with micronutrients which needs to meet the original sensory taste of water without any off taste, color and also to meet neutral pH. The most challenging is to meet without discoloration and off taste if fortified with vitamins and minerals as some of the nutrients like Iron poses several challenges, depends upon the type of iron used. Using water soluble iron sulphate or iron gluconate offer the advantages of providing the high bioavailability, but the disadvantage of getting the color of the resultant product [24]. On the other hand, water insoluble elemental iron or ferric phosphate offer poor availability. This can overcome by Flame spray pyrolysis technique which offers a method of cheap and bioavailable nano scale complexes for iron and zinc fortification [24].

But the objective of further research would be more appreciable to develop without any addition of flavors, sugar, preservatives, to micronutrients fortified mineral water and should taste as original mineral water with neutral pH.

Incorporating fish oils and fat-soluble ingredients into clear beverages has been a pretty big hurdle for the industry [25]. However, the above said are challengeable to develop new innovative product having more shelf life.

Hence, harmonizing food fortification policies, within the scope of optimal and safe levels, will enable suitable competition in global malnutrition deficiencies with no trade barriers.

### Conclusion

Technological advances have made to alter the processing of mineral water to fortify nutrients by modifying the process steps like ozonation/de-ozonation in a controlled way which in turn can avoid the oxidation of nutrients. This could make them ideal product without degradation of nutrients. Bioactive nutrients with coated forms in premixes could be possible to meet the challenges like nutrients degradation, off taste, discoloration etc. Fortified water available in the market are mainly flavored waters and high sugar content, however the increase in consumer's health consciousness to decrease the calories or no-calories and taste like original water has encouraged scientists and researchers to explore newer matrices as vehicles for nutrients particularly water. The human body needs water to survive and nutrition to function. Micronutrients fortified mineral water can fulfill two birds killing with one stone and drink a product that delivers both to human body. Everyone needs to drink 2-4 litres of water daily so why not drink water that has original taste of water and helps to keep body functioning. However, beverage choices and amounts vary widely between subgroups and individuals. But drinking water is must to one and all. There is a genuine interest in the development of nutrient fortified mineral water because they serve as a no calorie alternative for weight loss/obesity and health conscious consumers.

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