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Water Fortified With Minerals (Ca, Mg, Fe, Zn)

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ABSTRACT

The many health attributes of functional beverages have resulted in the rapid growing of their market sale. Water-based beverages fortified with minerals have made a new connection between the medical and food sciences. Functional beverages include a wide variety of products in the market. They are mainly fortified to be a substitution for what is lost in current diets. However, consumers never scarify tastes for health means, and their expectations of beverage functions depend on cultural differences across the world. In the current study, water-based beverage fortifications have been reviewed and substantiated with scientific data collected from published papers to show the value of adding fortified water with a range of functional ingredients including minerals from the individual and public points of view. Addition of various minerals has also been demonstrated to help establish a beverage market, which can satisfy consumers in any country.

Keywords: Fortification, healthy beverage, mineral-fortified water

INTRODUCTION

Consumers usually look for products that will supposedly prevent illnesses and improve their health. This has led to an unpredictable increase in demand for natural products, known as "functional (healthy) food products" [1–3]. Food products are regarded as functional if they are proven to be beneficial (e.g. reduce the risk of certain diseases, optimize health or have a positive impact on ageing process) [4–7]. In contrast, no clear definition has been reported for functional foods [5]. The nutritional function of food products, considered as the basic supplier of nutrients to the body, is highly important. New beverages are expected to answer age- and gender-specific health concerns. While beverages target weight and cholesterol reduction, tension reduction, metabolism improvement, mental fitness and concentration, these special drinks are produced to help prevent or cure chronic diseases in elder people. There are certain beverages produce for pregnant or post-menopausal women in order to maintain their inner balance [6, 8, 9]. A fortified food must use locally available carriers legally. The best alternative carrier can be drinking water. Much epidemiological evidence exists, indicating that mineralized drinking water lowers the risk of osteoporosis, severe nutrient deficiencies, and the death toll of cardiovascular diseases (CVDs) [10–15].

High-calcium intake influences the maintenance of peak's bone mass and subsequent bone loss. The same condition has been reported for other nutrients such as magnesium (Mg), as it has an important role in several fundamental cellular reactions, including many enzymatic and biologic mechanisms. So that Mg deficiency can end with severe biochemical changes. It has been shown that usual diets are no longer able to fullfil the recommended dietary needs for Mg [11, 14, 16–19]. Considering the fact that oral intake of calcium (Ca) is an advantage, the best strategy to

prevent Ca deficiency and osteoporosis is to add the most bioavailable form of Ca salts (the adequately water soluble form) to the beverage. This Ca-fortified water can be used individually as the bone healthy water or base of beverages with various tastes and colors [13, 20, 21]. A variety of Ca salts, either organic or inorganic, may be applied for beverage fortification. While various forms of Ca salts can be used with no changes in taste, appearance or physical properties of the beverage, Ca lactate gluconate is the most soluble form of the salt, and therefore, is highly recommended for fortification purposes. The salt alone and in the absence of chelating agents, can fortify clear beverages due to its ability to form metastable complexes. The bioavailability of Ca in Ca-rich water seems to be similar to that in dairy products and pharmaceutical supplements [11, 13, 16, 20, 21].

Fortified water can decrease the impact of low-dietary Ca on bone growth and mineralization significantly. Hence frequent drinking of Ca-rich mineral water either provides supplemental Ca and hydration, or inhibits intact parathyroid hormone (iPTH) secretion and bone resorption. Regarding this beverage's absorbability properties, while Ca absorption is highly important in preventing disorders such as osteoporosis, unabsorbed forms of the compound exerts useful functionality in the gut (through blocking the absorption of potentially harmful byproducts of digestion). Excess use of such a beverage does not raise any concern as there is huge evidence implying the little effect of water fortification on bones in the presence of adequate dietary Ca [16, 19, 20]. On the other hand, the best form of Mg salt to be used in beverage fortification is trimagnesium citrate, which is believed to enhance immune responses. Trimagnesium citrate, in its anhydrous form (16%), is the most economic option for adding highly bioavailable and soluble Mg with neutral taste to the beverage. Mg salts are known to be effective in preventing "sudden deaths" after myocardial infarction possibly by competing with sodium and potassium in the intestinal absorption and increasing the excretion of sodium. It is worthy to know that the important role of Mg in osteoporosis prevention has been reported in recent studies. A combination of Ca and Mg can be used in bone healthy drinks [22–25]. Ca and Mg-fortified waters can prevent osteoporosis. Drinking water containing relatively small quantities of Ca and Mg has positive health benefits [13].

Iron fortification of the water-based beverages can be a choice. Although iron-fortified water is not a pleasant drink due to its flavor, the best iron salt for this purpose, ferrous sulfate, can be masked with berry family flavor. Encapsulation or chelating agents such as ferrochel are other recommended options. Iron-fortified water raises the number of folic acid fortified products and thus eases the intake of folate [12, 26]. In addition, waters fortified with folic acid, vitamins B_6, B_{12} and D and Ca increase serum concentrations of erythrocyte folate and vitamin B_{12}, and decrease plasma concentration of homocysteine in normal hymocysteinemia individuals [6, 11, 12, 19, 20, 27–29]. Such beverages include favorable effects on the bones as well. The main objectives of this review were to show the health aspects of mineral-fortified water and study whether its addition to water-based beverages would contribute to production of valuable functional beverages to be used as a disease preventive strategy.

Functional beverage

Functional drinks, as a part of functional foods and soft drinks, are an appropriate response to the consumers' expectations. They can boost the immune system, decrease stress, increase vitality and stamina, control body weight, and fight degenerative diseases [8]. They further can prevent osteoporosis and anemia [12, 22–25, 26]. Optimizing doses of compounds in drinks is a challenge for the industries [3, 4, 6, 8, 9, 30]. Therefore, these beverages can play a key role in the functional food market [8]. They are non-alcoholic beverages that relieve thirst. The main ingredients of these beverages include herbs, vitamins, minerals and amino acids or additional fruit/vegetable raw ingredients. Encouraged by medical endorsement of exercising followed by a healthy diet and adopted stress management, health conscious consumers wish to spend money to drink favoring beverages that ensure better nutrition and increase the consumers' life quality.

Previously made aqueous medicines included functional and nutritional ingredients; however, they were not commonly accepted and used due to their medicinal properties. Moreover, use of these medicines is associated with a mentally feeling of physical weakness. According to Morse and his colleagues, this is not true in case of beverages; they are always consumed with relish as they are refreshing generally [31]. Therefore, functional beverages must be capable of convincing people that they are more beneficial, convenient and pleasing to drink than dietary supplements [3]. Data collected by Menard [5] from European markets show that functional beverages encompass a wide range of properties targeting different health related issues; mainly sports and energy drinks, teas, enhanced fruit drinks, soy beverages and enhanced waters [5, 8, 10, 32]. In Iranian market, sports and energy drinks and Oxygen-fortified water are available. Functional beverages are categorized into four main categories in the market: 1) enriched beverages, 2) sport and energy drinks, 3) nutraceuticals providing specific medical or health benefits, and 4) probiotics, which are mainly found in dairy drinks. Two other distinguishable functionality classes are: 1) drinkable supplements and 2) dietetic drinks, which are developed for individuals with specific nutritional needs [10, 32]. Beverage companies now differentiate their products based on their functions and needs of the consumer rather than flavors or marketing issues. However, the majority of these beverages target specific

populations including seniors, adults, women, professional and amateur athletes, teenagers, children, and even toddlers.

Fortified water, a functional beverage

Water is the first vehicle to deliver nutraceuticals and supplements required to produce a beverage. It is also the main component of blood and cells, and fills most of the extracellular spaces. Electrolyte balance is highly linked to the water balance, indicating that any change in one will alter the other. Although water is listed among the 41 essential nutrients [33], a little attention is given to it [16]. In WHO reports, water is considered as a good vehicle for fortification with iron and other minerals and vitamins [34]. To maintain electrolyte and water balance, the body is required to replace electrolytes and water, which are lost in urine, sweat, and feces. Many disorders, especially those causing fever, vomiting or diarrhea can also result in water and electrolyte imbalance. Beverages and foods are the main sources of water and electrolytes. Water constitutes over 60% of the body weight, and one most drink 6–8 glasses of water every day; however, for many people, finding adequate hydration is a great challenge. The ease of use, better hydration, and access to vitamins are the main benefits of aqueous beverages [1, 9, 16]. Furthermore, nutrients' bioavailability increases with their solubility in water [34]. The combination of energy compounds, electrolytes, stimulators, nutraceuticals and water can result in the production of a wide range of formulations for such a beverage. Traditional names available in the market to promote these products include: fortified water, power water, vitamin water and fitness water [33]. Some of the fortifying compounds used in water-based beverages are not water-soluble; hence they are incorporated into the beverages as encapsulated compounds bound to a protein or as a nano-emulsion [16].

Flavored water (enhanced water)

In general, flavored waters provide additional benefits to those of plain water. Consumers consider flavored water as a good replacement for soft drinks, which is easier to drink, and high in calories. Enhanced water is a water, which is "enhanced" with flavoring, aroma or such additives as vitamin and energy-producing herbs. According to Matkovic [16], “enhanced water” is, generally, used for any type of bottled water having ingredients aiming to improve its taste and/or offer supplementary nutritional benefits. The more popular is water fortified with nutrients such as Ca and vitamins [16]. However, no matter how nutritious the beverages are, their taste must be acceptable; otherwise, they would not achieve much popularity in the market. Flavors like wild berry, raspberry, cranberry, mango and passion fruits are commonly used in these beverages [35, 36]. While pomegranate is the fastest-growing flavor for new nutraceutical beverages, orange is the most commonly used flavor. The majority flavored waters contain sweeteners including sucralose, acesulfame potassium and aspartame [36].

DISCUSSION

The increasing trend for the consumption of refined foods has decreased mineral and vitamin intakes [11]. Therefore, there are many studies conducted with the aim of producing drinks with optimal composition in order to rehydrate the body in healthy manners. Previous studies have demonstrated water as a good carrier for minerals, vitamins and other neutricuticals [12, 20, 34]. Since water is available everywhere, and accounts as the base of almost all beverages, then it can certainly be easily fortified. However, drinking-water is seldom quoted in the literature as a micronutrient carrier [12, 34, 37]. It is 100% water, while the water content of other beverages ranges from 85–100%. Despite a limited research, studies reviewed in the current paper show that mineral-rich water can contribute to mineral balance and overall nutrition. There are numerous factors determining the relative nutritional contribution to both individuals and populations; they include the amount of minerals per volume, as well as the volume, frequency and regularity of consumption [37].

Mineral addition

Due to global awareness on water as an important source of mineral intake, shift from tap to bottled water consumption may have important implications on health and disease conditions. There is tremendous variation in the mineral content of bottled waters so that few of them have an optimal mineral profile [37]. Mineral lactates are used in a great variety of beverages for various health reasons. For example, Mg and Ca are good for bone health, whereas zinc and Mg can boost the immune system and prostate health [12, 13]. However, the amount of minerals in water and the amount of water consumed determine the degree of contribution of water to Ca and Mg intake [37].

Calcium addition

Ca-enriched beverages play a significant role in the growing market of functional drinks [16, 17, 21]. Ca has also a critical role in muscle contraction, nerve impulse transmission, bone structure, blood clotting and cell signaling. Therefore, low intake of Ca is associated with osteoporosis, rickets and hypertension [20]. Ca supplements are frequently prescribed because their effect is restricted to a few hours [14, 16, 18]. Hence, Ca-rich water must be consumed several times a day [14] because it increases ionized Ca this mineral [14, 21]. Oral intake of Ca

significantly increases its serum levels, lowers the iPTH concentration, and subsequently, promotes bone turnover (Tables 1 and 2) [14, 21]. Selection of an appropriate salt for a specific beverage is usually based on its solubility and economic considerations (Table 3). The bioavailability of Ca in fortified waters is found recently to be at least equal to that in milk (Table 4) [27, 37]. Absorption and urinary excretion of Ca sourced from milk and carbonate- and sulfate-rich water were compared by using a dual-label stable isotope technique in 21 to 36-year-old women. Nine women completed two study periods eating the same diet for the first 3 days. The subjects consumed either milk or Ca- and sulfate-rich water on days 4 and 5. The results showed that Ca from carbonate- and sulfate-rich water was absorbed and retained the same as the Ca from milk [37]. Accordingly, Heaney [21] concluded that the Ca in high-Ca mineral waters is highly absorbable, and that consumption of mineral water potentially accounts for a substantial fraction of the total intake daily of Ca [21].

The addition of Ca to water in clear beverages may be troublesome as highly soluble sources (such as Ca chloride) cause undesirable flavor and destabilize proteins [19]. Using atomic absorption spectrophotometry in vitamin D-deficient rats, Eledahe [38] determined the sensory threshold of Ca chloride in water and flavored water as well as the bioavailability of Ca from Ca chloride fortified drinking-water in nine commercial bottled and flavored waters. Also sensory detection thresholds of Ca chloride were calculated in tap water, deionized (DI) water, berry flavored water and a sports beverage formulation by five-series ascending forced choice analysis. Ascending Ca chloride concentrations in fortified drinks were evaluated by 30 assessors in duplicate trials. The acceptability of deionized and flavored water with and without Ca chloride was assessed by 98 consumers. Ca concentration of the nine commercial products varied from 0.3 to 116 $mg.l^{-1}$. Sensory thresholds for Ca chloride in drinks ranked as follows: flavored water (857 ±8.9 $mg.l^{-1}$) > sport drinks (844 ±9.8 $mg.l^{-1}$) > DI water (101 ±3 $mg.l^{-1}$) and > tap water (93.5 ±3 $mg.l^{-1}$), respectively. The thresholds were calculated based on Ca as follows: flavored water (7.72 ±0.08 mM) > sport drinks (7.60 ±0.09 mM) > DI water (0.91 ±0.01 mM) and > tap water (0.91 ±0.01 mM), respectively. There was no difference in consumer acceptability scores for water or flavored water with and without Ca chloride (70 and 700 $mg.l^{-1}$ or 0.63 and 6.31 mM, respectively) [38]. The content of Ca may be increased in flavored drinks or water by Ca chloride without impacting its acceptability. Though fortification of water will have a small effect on the bones if the dietary Ca is adequate, regular consumption of Ca-fortified water can decrease the effect of low-dietary Ca intake on bone growth and mineralization significantly [38].

Table 1. Characteristics of common calcium salts in the food industries [19, 27]

Calcium salt	Solubility at 25 ˚C [$g.l^{-1}$]	Taste	Calcium content [$g \cdot kg^{-1}$]
Calcium carbonate	Insoluble	Soapy, lemony	400
Calcium phosphate	Insoluble	Sandy, bland	170–380
Tricalcium citrate	0.2	Neutral	210
Calcium lactate	9.3	Bland	130
Calcium lactate gluconate	45–50	Neutral	100–130
Calcium gluconate	3.5	Mild, neutral	90

Table 2. Serum ionized calcium measured before and after drinking 0.5 L of low-calcium (< 5 mg elemental Ca) and high-calcium (172 mg Ca) mineral waters [14]

Mineral water	[$nmol.l^{-1}$]				
	Baseline	1 [h]	2 [h]	3 [h]	4 [h]
Low-calcium	1.252 ± 0.019	1.255 ± 0.022	1.250 ± 0.018	1.253 ± 0.019	1.246 ± 0.020
High-calcium	1.257 ± 0.027	1.293 ± 0.031[a]	1.286 ± 0.029[a]	1.278 ± 0.025[a]	1.268 ± 0.031[a]

Means in the same column with different letters are significantly different (P<0.05)

Table 3. Usage of various calcium salts in fortified beverages [19, 27]

Products		Additional calcium salt
Clear beverages	Still mineral water	Calcium carbonate/chloride/sulphate/lactate gluconate and tricalcium citrate
Near water drinks	Apple juice	
	Tangerine orange drink	Tricalcium citrate
Cloudy beverages	Apricot nectar	Calcium lactate
	Tropical nectar	Tricalcium citrate
	Soymilk	Calcium carbonate/citrate
Fruit juice	Cranberry juice	Calcium lactate gluconate
	Grape fruit juice	Tricalcium citrate
Fruit juice	Orange/tangerin juice	Tricalcium phosphate/calcium lactate/lactate gluconate
Instant beverage	Instant tea	Calcium lactate gluconate
	Beverage powder	Calcium lactate gluconate

Table 4. iPTH measured before and after drinking 0.5 L of low-calcium (< 5 mg Ca) and high-calcium (172 mg Ca) mineral waters [14]

Mineral water	[pmol.l^{-1}]				
	Baseline	1 [h]	2 [h]	3 [h]	4 [h]
Low-calcium	2.55	2.35	2.40	2.70	2.35
High-calcium	2.40	1.60	1.75	2.15	2.10

Magnesium addition

Mg, as accepted worldwide, is not only an essential cofactor for more than 350 enzymes, but also involved in energy metabolism as being required for phosphorylation [20]. The element has significant role in synthesis of protein and nucleic acid and is required for normal vascular tone and insulin sensitivity. Furthermore, it helps to maintain tooth enamel and is needed for the proper function of immune system [19, 22]. Today, it is well known that Mg and Ca are preventive essential minerals against osteoporosis [14]. It has been reported that higher intake of Mg increases bone mass. Based on a study by Guillemant [14], pairing Mg with Ca in 1:2 to 1:4 ratios is beneficial for osteoporosis prevention [23]. We have little information regarding the absorption of Mg from water [24]. Data from a matched case control analysis shows that mineral-rich water, provides 6 to 17% of the total daily Mg intake depending on the Ca concentration [11, 21]. Mg citrate, Mg gluconate, Mg lactate and Mg aspartate can be used as muscle relaxant [25].

Mg's Bioavailability is affected by many factors, such as dosage, source of the mineral, amount of the active ingredient and serum level of Mg in the body. Water soluble inorganic and organic Mg salts and chelates are generally, highly bioavailable. Trimagnesium citrate is absorbed better than Mg oxide for its significantly high solubility (Tables 5 and 6). In addition, trimagnesium citrate has neutral tastes and is economical because of its high-Mg content [19, 22]. Sabatier et al. [39] studied the bioavailability of Mg from Mg-rich mineral water (110 mg.l^{-1}) in females aged 25–45 years with or without meals, and found the absorption of Mg as 45.7 ±4.6% from water alone with a relative difference of 14.4%. They concluded that regular consumption of Mg-rich mineral water has a positive contribution to Mg requirements [39]. Verhas et al. [40] assessed bioavailability of Mg in men aged 25–42 years. They calculated mean bioavailability as 59.1 ±13.6%, and the range of absorption as 36.1 to 84.8%; absorption was inversely correlated with age [40]. Yang et al. [41] found a significantly decreased risk of having a very low birth weight child by increasing the level of Mg in drinking water. This suggests that Ca intake from drinking water exerts a significant protective effect on the subject, similar to a recent finding regarding the beneficial effect of hard water on cardiovascular factors [41].

Table 5. Initial solubility of magnesium salt [22]

Magnesium salt	Initial solubility [g.l^{-1}]
Trimagnesium citrate anhydrous	32.5
Magnesium gluconate	8.0
Magnesium lactate	7.0
Trimagnesium citrate nonhydrous	2.5

Table 6. Magnesium content of magnesium salts [22]

Magnesium salt	Magnesium content [g· kg^{-1}]
Trimagnesium citrate anhydrous	160
Magnesium gluconate	80
Magnesium lactate	100
Trimagnesium citrate nonhydrous	120

Iron addition

As an essential nutrient, Iron is found in numerous enzymes and hemoglobin [31]. Iron deficiency is a common nutritional disorder [28, 31]. Supplementation of Iron in the form of tablets and syrups has failed due to poor compliance of the patient's secondary to the negative side effects of high concentrations of elemental iron in tablets and syrups. Fortification is the most cost effective, long-term approach to reduce Iron deficiency prevalence [28]. Among the various iron salts, $FeSO_4$ is more beneficial for fortification due to its high bioavailability and low price. Furthermore, ferrous gluconate has a good solubility in water-based beverages, and is harmonized well with flavors like wild berry and cherry [28]. For being frequently used during the day, soft drinks are ideal carriers to supply increased amounts of iron [28, 31]. It has been reported that adding elemental iron to drinking water decreases the iron deficiency incidence over a period of time [26].

Adding iron compounds to water sources through encapsulation or binding to a stable compound or chelation with a ligand that limits iron's free flowing in water provides an iron-fortified drinking water that almost eliminates the

metallic taste. Highly bioavailable food-grade ferrous salts are ferrous citrate, ferrous fumarate, ferrous sulfate, ferrous gluconate, ferrous tartrate, ferrous succinate, ferrous lactate and ferrous amino acid chelates, as well as a mixture of these salts. Bioavailability of iron increases when administered in the form of chelates. Chelated iron compounds or amino acid simply chelated irons are referred by such names as iron proteinates and iron amino acid chelates. Ferrochel, a desirable amino acid chelated iron, is a free flowing fine granular powder that provides a high bioavailable source of ferrous iron (Fe^{2+}). It is typically chelated or complexed with glycine [13]. Adding amino acid chelated iron compounds such as ferrous amino acid chelates to a water source provides a highly bioavailable iron-fortified water without the metallic taste as they include a ligand to metal ratio of at least 2:1. The body prefers to use ferrous iron rather than ferric iron (Fe^{3+}) [42].

Laboratory experiments, such as physical and chemical tests, were carried out to assess the effect of adding iron salts to drinking water on its color, turbidity, and taste. It was shown that iron citrate, gluconate, chloride and ferrous sulfate at 1 and 5 $mg.l^{-1}$ concentrations caused tiny color changes. A clinical study evaluated hemoglobin and ferritin levels by consuming drinking fortified water with ferric hydroxide, ferric chloride, ferric gluconate, ferric sulfate, ferric ammonium citrate and ferric nitrate by using physicochemical tests and acceptance trials in 500 children. The children were quickly adapted to the low metallic taste of ferrous sulfate. After 35 days, control animals became anemic and had 9.1 $g.dl^{-1}$ of Hb 13.0 to 13.9 g of Hb in the animals who received ferrous sulfate, NaFeEDTA and Fe glycine chelate, and 10.6 $g.dl^{-1}$ of Hb in the animals that drank iron orthophosphate. Hemoglobin, hematocrit, weight gain, iron hemoglobin, transferring saturation and relative iron biological values were checked in all subjects. After drinking iron-fortified drinking water (ferrous sulfate only) the anemia decreased significantly. The number of Fe-deficient children decreased considerably after drinking Fe-enriched water. Also after eight months mean hemoglobin values increased from 10.6 to 13.7 $g.dl^{-1}$ and serum ferritin from 13.7 to 25.6 $mcg.l^{-1}$. There were no problems associated to ferrous sulfate or Fe-enriched water. The conclusion is that Fe-enriched water is practically a good alternative to prevent anemia [34].

Zinc addition

Due to self-imposed dietary restrictions as well as low intake of trace minerals, marginal zinc-deficiency is very common. Zinc and Iron and deficiencies can be prevented via taking supplements or increasing the intake of fortified beverages. These elements can be delivered together with other vitamins and minerals such that they hold higher bioavailability, lack non-objectionable taste and appearance and also in a form that a majority of the population can consume them [13]. Zinc compounds that are added to beverages are chloride, gluconate, sulfate, picolinate, acetate, aspartate, ascorbate, citrate, and zinc oxide as well as zinc amino acid chelated. However, zinc gluconate and amino acid chelated zinc are particularly preferred because of taste, containing at least 5 ppm of zinc resulting in 5 to 100 United States Reference Daily Intake (USRDI) per serve. In addition, zinc compound is better encapsulated in very small dispersed particle size; not visible in the solution [13, 42]. In order to improve iron and zinc deficiencies in general population, there have been efforts aiming at formulating fruit flavor dry beverages supplemented with zinc and iron with or without vitamins; a few of them are bioavailable, safe, organoleptically acceptable and cost effective. Water-soluble iron and zinc compounds that are the most bioavailable cause unacceptable metallic taste and flavor changes. By the invention of Mehansho et al. [42] in 2011, a mineral-fortified water composition was produced with at least 1 ppm of iron and at least 5 ppm of zinc; both present in the form of amino acid chelates (pH 2.5 and 9.5, respectively). This beverage has almost no flavor, sweetener compound, metallic taste or after taste [42].

Functional beverage with fortified water effectiveness in individuals

Beverages were designed using fortified water, Ca (Ca lactate), folic acid, vitamin D, B_6 and B_{12}, with the aim of supplementing the diets with folate and homocysteine micronutrients [43].

Functional beverage with fortified water effectiveness in population

Various surveys have shown that consumers often are not familiar with the term "functional" or similar words; however, they show a high agreement to the concept. Thereby, acceptability of a functional beverage is mostly dependent on the clients' awareness on the health effects of the added ingredients to that beverage (Table 7) [44]. Therefore, traditional functional ingredients like vitamins, fiber, minerals and omega-3 have higher acceptability than newly introduced ones such as carotinoids and flavonoid. Health image of a functional product represents a necessary prerequisite; however it is not sufficient enough for its market success [5]. Furthermore, functional ingredients differ from one area to another one. Nowadays, the consumers in the United States prefer more natural concepts; therefore, use of minerals and vitamins in beverages is becoming very popular [8].

Table 7. Consumer awareness of functional benefits of ingredients [44]

Main most used functional ingredients in beverages	Awareness [%]
Antioxidant	37
Calcium	84
Fiber	67
Flavonoids	10
Iron	92
Omega-3	28
Oligosaccharids	5
Probiotic cultures	38
Selenium	36
Vitamin D	82

CONCLUSION

There are numerous products in the market labeling functional beverages. Consumers' expectations for these products, in fact depend on the claimed health benefits. One important fact is that has health benefits should always be substantiated with scientific data. In the growing market of functional drinks, absence of technical substantiation and lack of regulation could easily result in collapsed market. For example, in Iranian fortification regulation, water has been in the inhibited list of foods for fortification since 2013. However, considering the beneficial effects of fortified foods, water was excluded from the list, and allowed to be fortified in the revised version of this regulation. Currently, oxygen-fortified water as well as sport drinks have been registered in the Food and Drug Organization database.

The aim of fortified beverage manufacture is to provide a reasonable portion of the recommended daily intake for minerals and vitamins in each serve. Many researchers have studied the economic aspects of fortifying or enrichment. There are still rooms for the use of raw materials, through finding new applications or taste profiles, and elucidating the previously unknown functions. The most important character in food industry is taste; it could be in plain water or in functional beverage. Therefore, to increase the public to consume more beverages, flavor should be engineered in such a manner that no calorie concern is raised but balanced taste. Simply flavored enhanced water or beverage is the best way to introduce functionality to consumers. This is now proven that water fortification has made major contribution to better intake of vitamins and minerals. Multiple beverage fortification strategies have numerous advantages because they facilitate distribution processes, provide high levels of acceptance, are capable of providing beverages isolated from meals having substances like phytates, and can be purchased by private consumers rather than reliance on government programs. An alternative approach is the development of a micronutrient fortified liquid beverage introduced to both markets and special feeding strategic programs; this has dual benefits of reaching a wide range of consumers and providing an enjoyable healthy beverage.

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