

Probiotic Novel Beverages and Their Applications

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ABSTRACT

Natural substances are generally preferred over chemical ones and are generally considered as healthy. The increasing demand for natural ingredients, improving health and appearance, is also attracting beverages as the fastest growing segment on the functional food market. Functional beverages are launched as fortified water, tea, dairy or juices, claiming overall nutrition, energy, anti-aging or relaxing effects. The substitution of so-called superfruits, such as berries, grapes, or pomegranate, delivers an effective range of beneficial compounds including vitamins, fatty acids, minerals, and antioxidants. In this context, new exotic and African fruits could be useful sources in the near future. Teas and green botanicals, such as algae or aloe vera, are also rich in effective bioactives and have been used traditionally. The botanical kingdom offers endless possibilities.


Introduction

Beverages do more than quenching thirst. Bioactive ingredients should balance nutritional deficits, support physical and mental health, and may improve beauty from within. Consumers tend to favor a healthy lifestyle and the nutritional choices that go with it. As natural substances are clearly preferred over chemical ones, functional botanical ingredients are more popular than ever on the beverage market. New functional beverages like fortified water, tea and/or dairy products have increased their convenience, novelty, fun and image, but maintain their status as healthy drinks. Bioactive botanicals are used as functional ingredients in conventional foods to be marketed as functional foods. Among these functional foods, teas and non-alcoholic, non-carbonated bottled beverages are especially popular. The analytical assessment of these ingredients in functional foods and beverages presents

a new challenge because of low levels of analytes and the matrix complexity.^[1] Recent development of analytical methods has been for the determination of bioactive constituents from St. John's wort (*SJW*; *Hypericum perforatum* L.), ginkgo (*Ginkgo biloba* L.) and kava (*Piper methysticum*, Forst.) in functional beverages. The constituents selected as marker compounds were hyperforin, adhyperforin, hypericin and pseudohypericin for SJW, five terpene trilactones (ginkgolides A, B, C and J, and bilobalide) for ginkgo products, and six kavalactones (methysticin, dihydromethysticin, kavain, dihydrokavain, yangonin and desmethoxyyangonin) for kava products. The methods developed include improved sample preparation, liquid chromatography with ultraviolet/photodiode array detection (LC/UV/PDA), LC with evaporative light scattering detection (ELSD) and LC with mass spectrometry (MS).^[2]

Food and Drug Administration divides liquid dietary supplements and beverages

The difference between liquid dietary supplements and beverages bearing novel ingredients is the subject of new guidance from the Food and Drug Administration (FDA)^[3] which has become concerned about practices occurring in the area. It highlighted two main concerns: drinks being marketed as dietary supplements and the use of novel ingredients and high-dose ingredients in beverages and the labeling implications which may follow from that. "We have seen an increase in the marketing of beverages as dietary supplements, in spite of the fact that the packaging and labelling of many liquid products represent the products as conventional foods," the FDA guidance states. It also states, "Products that are represented as

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conventional foods do not meet the statutory definition of dietary supplements".^[4]

Novel and high-dose ingredients

On novel and high-dose ingredients, FDA observes: "FDA has seen a growth in the marketplace of beverages and other conventional foods that contain novel ingredients, such as added botanical ingredients or their extracts. Some of these ingredients have not previously been used in conventional foods and may be unapproved food additives. In addition, ingredients that have been present in the food supply for many years are now being added to beverages and other conventional foods at levels in excess of their traditional use levels or in new beverages or other conventional foods."^[5]

This trend raises questions regarding whether these ingredients are unapproved food additives when used at higher levels or under other new conditions of use. Some foods with novel ingredients also bear claims that misbrand the product or otherwise violate the Federal Food, Drug, and Cosmetic Act."^[6]

Drinks versus supplements

FDA highlighted single or multiple servings of beverages like soda, bottled water, fruit juices, and iced tea as examples of consumption occasions as a regular foodstuff and not as a dietary supplement: "Liquid products that suggest through their serving size, packaging, or recommended daily intake that they are intended to be consumed in amounts that provide all or a significant part of the entire daily drinking fluid intake of an average person in the US, are represented as beverages." Such products, the FDA said, "may not be marketed as a dietary supplement."^[7]

The market situation and trends

While some established nutritional markets, like dietary supplements, have been growing more slowly than they did in the 1990s, specific other segments (such as functional beverages) are growing faster. In the functional food category, functional beverages are the fastest growing segment. In the forefront of consumer interest are substances with antaging, energy supplying, relaxing, or beauty enhancing effects. Functional beverages (among them,

sports and performance drinks, energy drinks, ready-to-drink teas and designer waters) have acquired a claim to being healthy recently.^[8] They meet the consumers' demand for good taste and ingredients that are good for physical fitness and mental well-being. Consumers riding the exercise and healthy diet trend demand a measurable, noticeable health benefit from their functional beverage, and they are growing in number. This development has led to functional beverages becoming mainstream, and big beverage companies are merging with or acquiring small successful companies. Still, as this contribution attempts to show, there is room for new ideas and botanical enhancements discovered by food science. There are numerous advantages of using botanical extracts in beverages, functional or otherwise. They offer a wide range of active components and functions and a wide range of known raw materials, which means little or no consumer education is necessary prior to bringing a new product to market.^[9] There is still room for new uses of known raw materials, either by creating new applications or taste profiles or by scientific elucidation of previously unknown functions. The natural colors and overall natural origin of botanical extracts also lend themselves very well to addressing the consumers' desire for more nature in their drinks, which promotes the healthy properties inherent in them. Figure 1 shows probiotic beneficial effects on human health. Additionally, there is an increasing trend across the market toward using botanicals, which is supported by marketing their natural and beneficial aspects.^[10] There is also an increased preference for plant ingredients over animal derived ingredients, but they should be organic, not merely natural. As a consequence, medicinal plants used traditionally in Europe have found their way into beverages in small amounts, lending not only new taste, but also the appeal of a health-promoting ingredient, even if their concentration is insufficient for any actual pharmacologic effect. Figure 2 shows graphical representation of a nutraceutical. Another trend is the increasing consumer interest in ethnic and traditionally used products. Noni, Cat's claw and Baobab are examples of plants used in new products that have recently entered the market.^[11]

Fruit as beverage ingredients

Using fruit as ingredients for beverages means using a marketing advantage based on the aura of health surrounding the fruit. Fruit beverage brands that reach \$60 million in almost no time

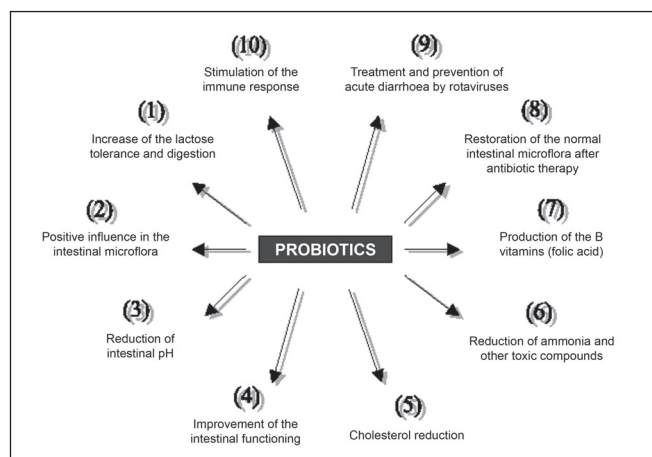


Figure 1: Probiotic beneficial effects on human health

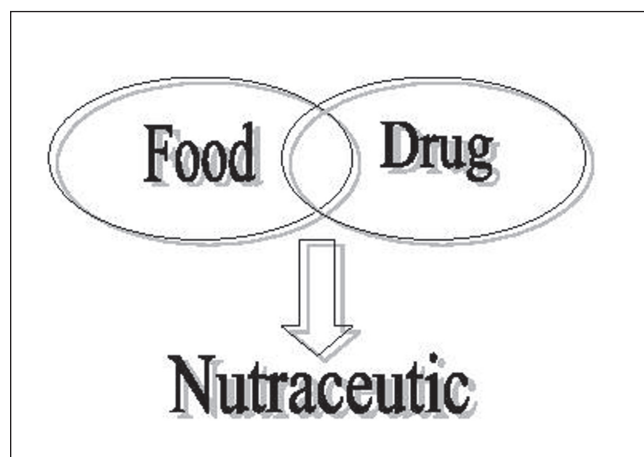


Figure 2: Graphical representation of a nutraceutical

demonstrate this. Combining innovative packaging, new delicious taste, and clever marketing is more successful than trying to deliver a health benefit, as it can be regarded as intrinsic in a fruit. There are hundreds of beneficial compounds present in the various berries. Among these compounds are polyunsaturated fatty acids, flavanols (anthocyanins and proanthocyanidins), flavonols (quercetin), and ellagic acid, all of which combined not only have antioxidant property, but also deliver antimicrobial, anti-inflammatory, and anti-mutagenic properties.^[12] Among the varieties of domestic fruit, sea buckthorn (*Hippophae rhamnoides*) recently has drawn attention to itself because of its nutrient density of almost 200 active phytochemicals, which contain among them unsaturated fats, carotenoids, and high amounts of vitamin C.^[13] The juice consists of three phases, each containing a different substance profile and lending to different beverage applications with a high manufacturing potential. The plant is native to northern Europe and Asia, where it has been used as a traditional herbal remedy.

Blueberries, native to Europe and North America, help to protect the brain and central nervous system by increasing serum antioxidant status, which is linked to a reduced risk of chronic and degenerative diseases.^[14] Blueberries and their close relatives, cranberries, have been shown to be effective in combating bacterial infection, especially in the urinary tract. This property, especially in cranberry juice, has been well studied for its ability to prevent *Escherichia coli* from adhering to the epithelial wall of the urinary tract, limiting the development of a urinary tract infection.^[15] Cranberries have a similar effect on *Helicobacter pylori* and the gastric wall, especially when administered in combination with traditional antibiotics.^[16]

Bilberry has been famous for a long time for its beneficial effect upon visual acuity. Anthocyanins in bilberry have produced positive results for night vision,^[17] an effect that has anecdotally been reported by pilots as far back as in World War II. Specifically, these anthocyanins can increase capillary resistance, reduce abnormal vascular permeability, and scavenge free radicals. Extracts of bilberry recently have shown effectiveness in improving visual function in adults with overworked eyes, which is certainly a problem in the age of computer work.^[18]

Another well-known and popular fruit, the strawberry, also packs quite a healthy punch.^[19] Its range of active substances (including anthocyanins, ellagic acid, and other phytonutrients) can decrease the effect of toxins and limit oxidative damage to DNA, which is the key to antioxidant protection against a number of forms of neurodegeneration and cancer.^[20] Antioxidants derived from strawberries also play a role in helping to lower the risk of cardiovascular diseases.^[21] Anthocyanins are also abundant in grapes, as are proanthocyanidins, quercetin, and resveratrol.^[22] These are central to this berry's noted benefits for atherosclerosis and cardiovascular disease, including decreased lipid oxidation, cholesterol aggregation, reduced blood pressure, and improved vascular endothelial function, as well as reduced cell adhesion, a factor in inflammation.^[23-26] Other berries have shown impressive benefits, according to various research results.

Blackberries were shown to impede tumor formation in the oral cavity,^[27] while anthocyanins and other phenolics present in boysenberries and black currants were found to protect cellular DNA against oxidative damage, and black currants combined with bilberries, lignonberries, and raspberries may protect against lipid oxidation and increase antioxidant capacity in plasma.^[28] Raspberries work well with other berries. Combined with blueberries, they inhibit mutations in breast and cervical cancer cells. Along with

cloudberry, they counteract both gram-negative and gram-positive bacteria. A clever approach to get daily rations of fruit is to use known fruits, such as strawberries, blueberries, and cranberries, in fruit smoothies or juices. As science keeps substantiating the age-old adage that fruit is good for you and supplies the consumer with knowledge regarding the active substances contained in fruit and their effects, the beverage industry gladly provides new means of eating them without the hassle of preparation. One new approach is the combination of various domestic berries to achieve a synergy of effects, while using the appeal of a new product without the regulatory hassle of introducing a new fruit to the market.^[29-31]

Baobab (*Adansonia digitata*) has a long history of traditional use in ancient Egypt as a treatment against fevers, dysentery, and bleeding wounds, and it has a long history of nutritional and medical use in Africa. The pulp, rich in vitamin C,^[32] is used today to make drinks because it dissolves easily in water and has a pleasing taste. Fermented milk drinks and iced drinks using the pulp also are popular. The Baobab's antioxidant and anti-inflammatory properties make it valuable for a variety of applications in beverages; it also has proven to be an effective probiotic ingredient.^[33] Baobab pulp can be used in soft drinks, natural fruit smoothies, fruit fillings, jams, sauces, puddings, and desserts. Clearly, the possibilities for product development using Baobab fruit pulp are numerous.

Devil's Claw (*Harpagophytum procumbens*) is among the "new" African botanicals with potential use for beverages, but it is better known for its application in medicine, specifically as an effective therapy for rheumatoid arthritis.^[34-38] Recently, attempts to cultivate this plant (which, until recently, could be harvested only in the wild) have proven successful. Its traditional use as a digestive aid has prompted research into its possible application as a beverage. If successful, the already high acceptance of the plant by physicians and consumers will give it a head start in this marketing segment.

Sausage tree (*Kigelia pinnata*), with the suggestive shape of its fruit, has a long history of medicinal and food use, including being a common ingredient in traditional beer. Extracts made from the fruit have displayed potent antioxidant and anti-inflammatory activities.^[39,40] A variety of food and beverage applications using these extracts are possible, not to mention expanding on the existing tradition of the fruit as a beer ingredient. A parallel development of nutraceutical, cosmeceutical, or supplement applications on the basis of *Kigelia's* many potent health-promoting properties would increase recognition and acceptance of the plant.

Another plant with a long history of use (in this case, the Stone Age) is marula (*Sclerocarya birrea*). All parts of the plant are used; its plum-like fruits are traditionally brewed into beer, but also lend themselves very well to being used in the beverage industry.^[41] Marula flavor is similar to that of grapefruit because of the non-volatile substances that cause bitterness; its smell is reminiscent of pineapple. The fruit tastes like a cross between an apple, a litchi, and a guava. Many products containing marula are already on the market in juices and liquors, and many more are sure to follow.

The yellow ximenia (*Ximenia* spp.) fruit traditionally is eaten raw or made into jellies, jams, or syrup. Therefore, it is an ideal food ingredient for a variety of applications another fruit whose potential is untapped.^[42]

Mabola plum (*Parinari curatellifolia*) is another traditional African multipurpose plant with medicinal uses for its bark, cosmetic uses for its oil, and beverage use for its yellow, plum-like fruit. The fruit pulp contains vitamin C, sugar, and mineral ions, making it a valuable basis for soft drinks and other food applications.^[43] The acai berry (*Euterpe oleracea* Mart.), native to the Amazon rain forests and a

traditional staple of Amazonian diets, has drawn attention to itself recently, particularly in the United States. This small black berry boasts high polyphenol content and an omega-6 to omega-9 ratio comparable to olive oil.^[44,45] In addition, its anthocyanin content is up to 33 times higher than that of red wine. There are other benefits such as a nearly perfect amino acid profile and essential trace mineral contents. In addition, it has a pleasing flavor reminiscent of boysenberry or cherry with chocolate overtones. While research into acai's actual disease prevention capability is scarce at present, there are indications that it may be effective against a variety of diseases that have proven susceptible to black raspberries and blueberries.^[46]

The berries of *Lycium barbarum*, the Himalayan goji, have shown neuroprotective and hepatoprotective properties.^[47] Also called wolfberry, the plant is related to the tomato and has been a diet staple in China for several thousand years. The antioxidant properties of wolfberry are among the highest found in the plant kingdom, and traditional usage attests potential benefits against cardiovascular and inflammatory diseases, diabetes, premature aging, memory deficiencies, vision degeneration, lung disorders, and even some forms of cancer.^[48,49] It has been cultivated for a variety of food and beverage applications because its pleasant nut-like taste is complementary to a number of preparations.

Noni (*Morinda citrifolia*) is a fruit traditionally used in Polynesia for hundreds of years. Its uses range from medicinal to dietary; its constituents include vitamins C and E, amino acids, numerous minerals, polysaccharides and carotenoids, and omega-3 and-6 fatty acids. Many health benefits are expected from this nutrient profile, and there are indications from traditional usage of the fruit for possible anti-cancer mechanism.^[50] The tropical evergreen tree mangosteen (*Garcinia mangostana*) bears purple fruit consisting of a pericarp with multiple functional uses and a fleshy interior that lends itself to beverage applications. The fruit pulp contains various minerals, vitamin C, traces of B vitamins, betacarotene and beta cryptoxanthin, and fat, protein, and various carbohydrates.^[51]

Green botanicals in beverages

Green foods provide nutrients like vitamins, proteins, minerals, and antioxidants, which are researched for numerous health benefits. The challenge is masking the taste generally associated with green foods. One way to meet this challenge is to extract the nutrients at low temperatures, which lowers the risk of extracting undesirable taste factors.^[52]

The cereal grasses (young shoots of grain-bearing plants), including alfalfa, barley, wheat, rye, oat, and kamut, are also beneficial. In their jointing stage, these plants contain peak concentrations of phytonutrients, vitamins, and amino acids. Juice made of wheat grass has been effective in reducing disease activity of ulcerative colitis and some forms of genetic blood diseases involving anemia.^[53] Clearly, more research is needed to uncover additional unknown benefits in other species of cereal grasses.

One other main type of green food is microalgae, including spirulina, chlorella, and *Aphanizomenon flos-aquae*, *Dunaliella* and *Haematococcus*. These most primitive plants grow in aqueous solution, and because of their simple cellular structure and access to water and important aquatic compounds, they convert sunlight to sugars more efficiently than do higher plants. They are easily digestible because they lack a cell wall. Research has shown these microalgae to possess various properties of disease protection.^[54]

Aloe vera is another example of a well-known cosmetic ingredient

increasingly used in beverage applications, mostly in dairy products. The plant (the many benefits of which have been used for at least 4000 years) contains more than 200 active substances. There is a broad range of its effects, among which immunostimulation, digestive aid, anti-diabetic activity/blood sugar balance, kidney stone prevention, oral/gum health, anti-inflammatory for joint comfort, cholesterol/triglyceride reduction, and antioxidant protection and detoxification are exploited in beverage application.^[55] It is not surprising, therefore, to find Aloe incorporated into a multitude of functional beverages, exploiting the health and beauty connection that is increasingly moving into the consumers' awareness.

A popular but not new botanical ingredient, lemon verbena, deserves mention. It has certain therapeutic properties and has been used for a variety of ailments, including relief of digestive tract spasms, reduction of fever, strengthening of the nervous system, stress relief and as an anti-spasmodic and expectorant.^[56] Lemon verbena leaves can be steeped in hot water to create an aromatic and mildly sedative herbal tea, and its extracts are used in a variety of functional bottled waters.

Hibiscus (also not new to the beverage industry) is a red flowered annual herb and a tropical plant that is commonly used in jams, jellies, sauces, beverages, and teas. It provides a tart, refreshing flavor to these foods and drinks.^[57]

Teas and tea alternatives

No overview on botanicals used in beverages would be complete without mentioning the many tea varieties. The recently elucidated benefits of many teas have made tea extract an attractive additive to functional waters and have increased the sales of the beverage itself. Tea contains three types of polyphenol flavonoids: catechins, theaflavin, and quercetin. The potency of the polyphenols is determined by the varying processes used in tea manufacturing. For example, white and green teas typically receive the least processing; therefore, their naturally occurring catechins are preserved with the greatest efficacy. Other varieties of teas (e.g., black, oolong) are oxidized (i.e., fermented), resulting in the production of more complex theaflavins. Tea extracts formulated for high polyphenol content can contain the greatest amounts of beneficial substances because they are highly concentrated formulations.^[58]

Black tea consists of the withered, fully oxidized (i.e., fermented) leaves of *Camellia sinensis*. The purpose of oxidation is to achieve a richer flavor. Black tea is used mostly as a beverage. A meta-analysis of demographic studies concluded that consumption of black tea beverages might ensure positive health effects because of high levels of flavonoids in black tea, which can protect cells and tissues from oxidative damage by scavenging free radicals.^[59]

Green tea (*C. sinensis*), with its high content of xanthines, has anti-inflammatory, anti-irritation and cellulite reducing properties, while the polyphenols contained therein have powerful antioxidant effects that are 20 times stronger than vitamin E. Its extract has a healthier aura than black tea, making it more attractive to some consumers. Recent studies have shown that green tea increases the metabolic resting rate, making it a popular ingredient in weight loss supplements.^[60]

White tea, a rare variety of *C. sinensis* from China, is the least processed form of tea. It is not oxidized or withered, but simply dried by steaming, which leaves it with greater polyphenol content than other types of tea. It is a little less mature and still has buds on it, whereas only leaves are used in other types of tea. Research has

shown that white tea has potent anticancer qualities. With the surge in white tea offerings in the ready-to-drink tea market, it is only a matter of time before this trend will catch on in the supplement area. White tea has an exotic aura about it which appeals to customers looking for a point of differentiation.^[61]

Green coffee bean extract contains chlorogenic acid, which is twice as effective in neutralizing free radicals as green tea extract. It contains the same amount of caffeine as boiled coffee, but unlike boiled coffee, the extract is free of cafestol, which increases low-density lipoproteins concentrations. Making a coffee-like beverage containing green coffee extract without the less healthy aspects of conventional coffee is certainly an interesting concept. Caffeine, like green tea extract, raises the resting metabolic rate, a mechanism which is quite trendy in the beverage industry. Add the antioxidant quality of chlorogenic acid, and you end up with a very attractive beverage ingredient.

Yerba mate, with its long traditional use in South America, is valued highly for its nutritional profile. It contains vitamins A, C, E, B1, B2, niacin and B5 and calcium, chromium, manganese, iron, selenium, potassium, magnesium, phosphorus, and zinc. Other bioactives are carotene, fatty acids, chlorophyll, flavonols, polyphenols, inositol, trace minerals, antioxidants, tannins, pantothenic acid, and even amino acids. The extract has many health benefits besides being an interesting alternative to black and green tea.^[62]

Another tea alternative, rooibos tea, is known as the long-life tea in Africa. The so-called red tea is actually a herb (*Aspalathus linearis*). African women take rooibos during pregnancy to be relieved of heartburn and nausea; they take it for its iron content, and they give it to their babies to relieve colic. Rooibos is gaining acclaim for its vitamin, mineral, and antioxidant content and taste. It also is recognized for its anti-spasmodic properties, which help relieve digestive troubles. Unlike other varieties of tea, rooibos contains no caffeine. Its characteristic sweet flavor and high antioxidant content (about 50 times that of green tea) make it a very interesting beverage in itself and a valuable ingredient for wellness beverages.

Alternative beverages

The range of non-carbonated herbal beverages, sometimes called alternative beverages, is increasing. These beverages include energy drinks, exotic teas, and dairy drinks. Melissa, Siberian ginseng, echinacea, guarana, kava root, and *G. biloba* are some of the popular ingredients. These beverages are accompanied by claims and focus on "lifestyle" positioning, such as energy, calm, stimulation, relaxation, or health (e.g., protection against colds). Another popular group of ingredients in wellness and energy beverages are the adaptogens, substances that nonspecifically increase the resistance of an organism and do not disturb normal biological parameters. *Rhodiola rosea* is the best known of these and increases resistance to a variety of chemical, biological, and physical stressors. Its claimed benefits include anti-fatigue, anti-stress, antihypoxic (protection against damaging effects of oxygen deprivation), anticancer, antioxidant, cardioprotective, mood-enhancing/antidepressant, immune enhancing, and sexual stimulating effects. Another beneficial adaptogenic effect of *R. rosea* is its ability to increase physical work capacity, improving strength, recovery time, endurance, and coordination. A lesser-known adaptogen is ashwagandha (*Withania somnifera*). It has been shown to boost the body's resistance to anxiety and fatigue without any stimulant effect. Ashwagandha is a popular herb in the Indian Ayurvedic medicine tradition. The large range of herbal beers is

among the alternative beverages. Recipes are many and varied. One example currently on the market incorporates kava kava, scullcap (an herb in the mint family), St. John's wort, and passion flower. The manufacturer claims that the brew has the body, taste, and flavor of beer without the dulling effects of alcohol; it also has a relaxing effect on the consumer.^[63]

Perspectives of probiotic beverages

There is every reason to believe that beverages would be the next food category where the healthy bacteria will make their mark. Likely candidates are chilled fruit juices, bottled water, or fermented vegetable juices. The probiotic microorganisms also have been directly incorporated into the drinks. The key to the development of this second generation of the probiotic products is a special Direct Liquid Inoculation system. It allows food producers to add the probiotic bacteria directly to the finished food product. The innovation is expected to significantly boost the market for the probiotic beverages, which have so far been restricted by the delicate nature of the ingredient and concerns over the contamination. The probiotic bacteria must be alive to exert their health benefits but they can be destroyed by a number of processing situations. In beverages, for example, the heat treatment in a standard production run would kill the live bacteria. Adding probiotics to the juices is more complex than formulating in the dairy products because the bacteria need protection from the acidic conditions in the fruit juice. However, with microencapsulation technologies, the probiotics can become an important ingredient in the functional foods, expanding the probiotic application outside the pharmaceutical and supplement industries.^[64, 65] Microencapsulation technologies have been developed and successfully applied using various matrices to protect the bacterial cells from the damage caused by the external environment. It is the process by which small particles or droplets are surrounded by a coating to produce the capsules in the micrometer to millimeter range, known as microcapsules. Microencapsulation allows the probiotic bacteria to be separated from their environment by a protective coating. Several studies have reported the technique of microencapsulation by using gelatin or vegetable gum to provide protection to acid-sensitive *Bifidobacterium* and *Lactobacillus*. New product development requires detailed knowledge of both the products and the customers. The high reported failure rates for new international functional beverages suggest a failure to manage the customer knowledge effectively, as well as a lack of the knowledge management between the functional disciplines involved in the new product development process. The methodologies that advance both arms, understanding of the customer's choice motives and the value systems, and its knowledge management process, can increase the chances of new product success in the international functional beverages market. The commercial success of the probiotic products ultimately depends on taste and appeal to the consumer. The consumer needs to receive a comprehensible and reasonable message about probiotics, without it appearing to be exaggerated. The "health claims" must be defensible when placed under the scrutiny by the controlling authorities. In the coming years of the new millennium, changes would occur in the interface between the scientific studies and the acceptance by the consumers. With increasingly competitive markets, the functional food and the beverage manufacturers have targeted functionality as an extremely important marketing tool to create competitive advantages in the marketplace.^[65]

New research opportunities

The botanical kingdom offers practically unending opportunities to find new functional ingredients for beverages with a variety of techniques. As an author for the Physician's Desk Reference for Herbal Medicines and several other textbooks, the author has an extremely broad overview of the existing literature, plants, and their activities internationally. The partnership with InterMed Discovery has afforded the additional chance to use a high-tech pharmaceutical research platform and database consisting of tens of thousands of plant ingredients with new and never before published activities, permitting the discovery of completely new, patentable functional ingredients out of the realm of botanicals, more specifically, food plants, worldwide. This technology permits the separation of every plant into approximately 100–200 individual compounds, elucidating their chemical structure, and testing them in bioassays for new functionality. The advantage of the database is that thousands of plants have been analyzed, and many new activities have been discovered in bioassays, just waiting for the right partner to develop them into branded proprietary food ingredients.

Conclusions

Botanicals for beverages, which are divided into fruits and greens, present different challenges for incorporation in liquids. The beverage market itself comprises various segments such as juices, bottled waters, teas, dairy drinks, and alternative beverages. These groups, in turn, present their own challenges for incorporating ingredients. Among the many botanical ingredients currently available for beverage application, some have been around for a long time in other applications, while others (such as the various African fruits) are being discovered only now by the industry. The full potential of various ingredients has not been realized yet. With the discovery and elucidation of the health benefit mechanisms derived from known and unknown plants and with the development of extraction techniques suitable for beverage applications, many new tastes and claims will be realized in the future. Consumers are just learning the range of choices; so, there is no limit to new product lines with new ingredients or combining established ones to achieve new tastes. The industry is responding with mergers and acquisitions. Now discovery and extraction will provide the basis for these new product lines and the science to support traditional claims. Because equivalent high-tech research platforms are available, research opportunities are providing new functional ingredients for beverages.

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