Review Article

An Overview on the Health Benefits and Production of Fermented Functional Foods

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Abstract

Functional foods have a large and growing global market and are regarded as one of the most actively researched areas of food science. The growth in popularity of functional foods is attributed to the phenomena of consumer health care, increasing health awareness and knowledge in the many benefits of functional foods. Common benefits of functional foods include reduction of disease, health maintenance and prevention of nutrition related diseases. In this review, the current state and challenges for the production of functional foods by the help of bioprocess engineering are investigated. The present review also revisits the commercial impediments to provide insight for future works.

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Introduction

Over the past few decades the advancements in scientific knowledge linking nutrition to heath has greatly impacted nutritional choices of consumers. Food is now seen as a direct contributor to health and disease rather than just a source of nutrients and satiety (1). Consumers are now becoming increasingly conscious of the food products they purchase and consume leading to a noticeable trend towards choosing foods that are beneficial to health. This increase in demand has resulted in the perfect marketing potential for foods with added benefits thus inspiring the development of novel functional food products (2).

These foods can be referred to as “functional foods” which has multiple definitions ranging from simple to complex. It can be described as “foods that benefit one or more target functions within the body beyond basic nutrition” or “foods that improve the health and wellbeing of consumers and/or reduces the risk of certain diseases” (3). All foods can be regarded as functional to an extent as it provides nutritional value and taste; however foods that are generally marketed as functional have health promoting ingredients such as vitamins, minerals, bioactive peptides, oligosaccharides, probiotic bacteria and other biologically active compounds that carry out a range of bioactivities (1).

The idea of functional foods began in Japan in the 1980s where scientists began exploring the concept of food in relation to sensory contentment and nutritional benefits. Development of food fortified with additional nutrients or enhancement of naturally present components have been marketed to offer health benefits such as restoration of vitamin or mineral deficiencies or supplementation of essential nutrients. These foods later became known as Foods for Specified Health Use (FOSHU) in the Japanese market (4). This concept attracted the interests from various

western countries such as the United States as well as countries within Europe not only due to its marketability and commercial potential within the food industry, but also because it proposed a solution to lowering healthcare costs for the growing aging population (1).

Through many research studies it has been suggested that the reduction of disease risk can be attributed to the consumption of particular types of food or the active components within those food types(5). It should be noted that many of the functional foods that are being marketed today claim to have specific health benefits however these claims are often on the basis of emerging evidence rather than being based on sound scientific evidence (5).

Through and extensive research is not only for the purpose to legitimize the health claims of the functional food products; it is also for the safety of the consumers. It is important to identify functional compounds and analyze the various physiological effects it is able to carry out in order to prevent unwanted biological reactions and compromising the consumers' health (1). It is particularly important to be aware about the addition of substances to foods for enhancement purposes as it may have adverse effects on certain consumers, such as the addition of botanicals to enhance conventional foods such as cereals, soups and beverages. The safety problems regarding herbs are complex due to the lack of complete understanding of their biological activities thus the interaction between herbs and drugs have raised concerns (5).

In the early 2000s the General Accounting Office (GAO) released a report expressing the concern over the safety of particular functional foods stating that the FDA failed to develop regulations and provide guidance for companies that were producing functional foods and dietary supplements. Information regarding safety should be included on the product labels as absence of this information may result in a significant risk to consumers". The GAO then created several guidelines to help with maintaining the safety of functional foods. Guidelines included the development and enforcement of regulations on documenting and labeling information regarding the safety of new dietary ingredients or supplements as well as the development of a system that records and assesses reports of adverse health reactions to the new supplements and functional foods. Extensive research is critical in the development of a marketable novel functional food product due to its highly risky, expensive and complex nature. Significant effort must be put into identifying all the biologically active components, their physiological effects, a suitable matrix, the bio-availability of the compound and any changes that may occur during processing, preparation and consumption of the product. It is also important to take into account the education of the target audience as well as their needs in order to gain consumer acceptance. Although many functional foods seem promising for the future of public health, there are concerns regarding whether the evidence behind the claims are sufficient, sound or scientifically strong (5). The efficacy and safety of the functional food product needs to be rigorously researched to ensure no possible adverse interactions with biological systems may occur during the consumption. Functional foods serve as an effective strategy of administering therapeutic compounds, improving health and reducing certain health diseases however they should not be considered as a cure. Consumers must understand diet is just one approach to maintain good health. The effectively of functional foods will only be maximized when other aspects such as regular exercise, reduction of stress and practicing good health habits are incorporated into the individual's lifestyle (5).

Types of Functional Foods

Functional food products can be found in virtually all segments of the food and drink market and exert a variety of different functional properties. Some products are marketed to improve the quality of life with products such as probiotics that help with regulating stomach and colon functions. Other products have also been designed to reduce existing health problems like hypertension or high cholesterol. Lastly, functional food products have also been known to make life more comfortable and easier such as lactose-free products. Many of the functional food products developed today are in the dairy, confectionary, soft drink and baby food markets. The most recognized products on the markets today are probiotics and pre-biotic and functional drinks.

Functional foods can be manufactured via a variety of different methods for a range of purposes. The methods can include modification of existing foods or fortifying with beneficial substances that can either act to improve health or target specific diseases. The fermentation process is a method historically used to preserve food as well as enhance the flavours, textures and health benefits of food. This process where carbohydrates are converted into alcohols, carbon dioxide and organic acids can be carried out by yeasts, filamentous fungi and bacteria. A variety of foods can be fermented including milk products, cereal,

vegetables, fish and meat creating products such as yogurt, cheese, natto, kimchi and fermented sausages (6). Fermented beverages are common across many cultures using a variety of microbes to produce beer, wine, sake tea and fermented milk drinks such as kefir. A summary of the available fermented food products on the market, their health benefits as well as the microorganisms used in the fermentation process is presented in Table 1.

Table1. Marketed Functional Foods

Functional Food	Health Benefits	Used Microorganism
Fermented milk products: Yogurt Fermented milk product containing anti-microbials and probiotics (6)	Good source of probiotics. Promotes intestinal health, reduces cardiovascular disease (6).	***Lactobacillus bulgaricus, Streptococcus thermophilus*** (6)
Cheeses Contains a variety of nutrients such as vitamin A and B12, calcium, phosphorous, zinc and protein (7).	Maintenance of bone to prevent osteoporosis, bioactive properties such as anti-carcinogenic, anti-microbial and anti-thrombotic. Probiotic effects (7)	***Lactic acid bacteria*** *Lactobacillus strains, Bifidobacteria* (15)
Fermented vegetables: Kimchi Fermented cabbage and radish. (8)	Improved cardiovascular and digestive health, enhances immunity, reduces cholesterol and protects against oxidative damage thus anti-aging	***Lactobacillus* species:** *L. brevis*, *L.plantaru, Pediococcuspentosaceus, Weissella confuse, Weissellakimchii, Weissellakoreensis.* ***Leuconostoc*species:** *L.e. mesenteroides, Le. kimchii, Le. citreum, Le. gasicomitatum, Le. gelidum* (16)
Natto Fermented soy bean product (9)	Stimulates bone formation and prevents osteoporosis, reduces cardiovascular disease.	***Bacillus subtilis*** (9)
Sauerkraut Fermented cabbage Good source of probiotics, vitamin, dietary fibre, minerals	Digestive health, cardiovascular health, strengthening of bones, reduction of cholesterol, improves immunity, vision and skin.	***Leuconostocmesenteroides, Pediococcus pentosaceus, Lactobacillus species*** *Lb. brevis, Lb. plantarum, Lb. sakei* (17)
Fermented Meats: Fermented Sausages *(Salami, pepperoni)* Dehydrated and fermented meat product. Improves taste and prevent spoilage of meat (10).	Contains peptides that have anti-oxidant and antihypertensive properties (10)	***Lactic acid bacteria*** *Lactobacillus, Pediococcus and Enterococcus* (18)
Fermented Fish: Sea water Fish: *Sikhae*-Korea *Narezushi*- Japan Fresh water Fish: *Burong-isda*- Philippines *Pla-ra*- Thailand (11)	Rich source of proteins and amino acids. (12)	**Lactic Acid Bacteria** *Lactobacillus plantarum, Lactobacillus brevis, Leuconostocmesenteroides* Streptococcus species Pediococcus species (11)

Fermented Bread: Sourdough: Natural mixture of water and cereal flour that ferments over time by lactic acid bacteria and yeast, used in leavening of bread to produce its characteristic texture and sour flavour (6)	Sourdough has an increased mineral availability and also induces a lower glycemic response compared to other baked breads. The lactic acid bacteria in sourdough help with cereal intolerance by peptide hydrolysing toxic peptides and allowing easier digestion, especially for those who suffer from celiac disease (14).	**Lactobacillus species** *Lb. Sanfranciscensis, Lb. Alimentarius, Lb. Buchneri, Lb. Delbrueckii, Lb. Fructivorans, Lb. Plantarum, Lb. Reuteri, Lb. Johnsonii* **Yeast:** *Candida humilis*, *Issatchenkiaorientalis* (17)
Fermented Beverages: Wine: Fermented fruits, grapes wines are the most commonly consumed, however other fruits can also be used to make wines (12).	With moderate consumption: Improves cardiovascular health, hypertension, and diabetes. (12)	**Lactic Acid Bacteria** *Lactobacillus, Pediococcus, Leuconostoc,, Oenococcus* **Yeast** (19)
Tea (Chinese dark tea): Pu-erh tea is a type of post-fermented Chinese dark tea which improves in quality over time. It is post-fermented by fungi (13)	Antioxidant, antimutagenic and antimicrobial activities. Anti-obesity effects by decreasing levels of cholesterol triglyceride and LDL-C in liver and bloodstream as well as inhibition of lipid production and absorption. (13).	**Aspergillus Strains** *Aspergillus niger, Aspergillus wenti, Aspergillus sydowii, Aspergillus fumigatus, Aspergillus awamori, Aspergillus tubingensis, Aspergillus foetidus, Aspergillus phoenicis, Aspergillus peniciliode, Aspergillus dimorphicus, Aspergillus oryzae, Emericellanidulans* and *Glinocladiumcibotii*. **Penicillium Strains** *Penicillium oxalicum, Penicillium griseofulvum, Penicillium variable, Penicillium chrysogenum, Penicillium aculeatum* and *Penicillium citrinum.*

-Yogurt

Fermentation of milk has been known to provide therapeutic and nutraceutical properties that are beneficial to health. These properties are attributed to the probiotic strains of bacteria used to ferment milk. Yogurts are produced by the fermentation of milk by the bacterial strains Lactobacillus bulgaricus and Streptococcus thermophilus, which produce lactic acid that curdles the milk producing an acid as well as thick texture. The wide range of yogurt is primarily produced through the use of different types of milks with different fat content as well as additional ingredients such as flavors or fruits (6). Yogurt is a great and readily acceptable source of probiotics which are beneficial to multiple areas of human health including intestinal, immunity and cardiovascular health. The probiotic strains found in yogurt have antimicrobial effects which act as natural preservatives that prolong the shelf-life of the product (6).

Fermented milk products such as yogurt have lower lactose content than milk so they can be tolerated by individuals with less extreme cases of lactose intolerance. Individuals that have lactose intolerance have impaired or deficiency in β-galactosidase thus causes the inability to digest lactose into mono saccharides (glucose, galactose). The lactose enters the large bowel where it is degraded by bacterial enzyme causing diarrhea.

-Cheese

Cheese is a traditional fermented milk product that has been produced and consumed by various cultures around the world for many centuries. The wide range of cheeses available, each characterized by distinct flavors, aromas and textures are largely due to the type of microorganisms that carry out fermentation. Lactobacillus, Leuconostoc, Lactococcus and Streptococcus are the common lactic acid bacteria used as starter cultures to produce acid. The lactic acid plays a key role in controlling the rate of enzymatic activities which is responsible for the developing the characteristic flavours and textures of cheese. Cheeses are a great source of dietary protein, minerals and fat soluble vitamins; its nutrient content is determined by the type of milk that is used (20).

-Kimchi

Kimchi is a traditional Korean dish that is produced through the fermentation of vegetables such as cabbage and radish by lactic acid bacteria (16). Similar to the other fermented foods, fermentation is used to preserve vegetables for consumption during winter months when vegetables are not available. Kimchi's desired sour and sweet flavor is achieved at the stage just before the overgrowth of Lactobacillus brevis and Lactobacillus plantarum. The overgrowth of those microbes negatively affects the quality of the product (21).

Kimchi is a great source of probiotics which are important for maintaining intestinal health by increasing the amount of naturally present healthy gut bacteria as well as preventing the growth of helicobacter pylori bacteria which are responsible for stomach ulcers. During fermentation organic acids and anti-microbial compounds are produced by the microbes to not only control the growth of pathogenic microorganisms but also help with maintaining healthy gut flora. The fiber content in kimchi is in sufficient concentrations to exert prebiotic effects and help prevent colon cancer and constipation (11). Kimchi also contains many healthy functional ingredients including ginger, garlic and chilli which are all beneficial to human health. Garlic contains active compounds that are responsible for lowering LDL cholesterol and blood glucose as well as preventing plaque build-up on arterial walls which subsequently promotes cardiovascular health. Research has suggested that kimchi's other health benefits include anti-oxidative, anti-obesity, immune enhancement, promoting colorectal health and even anti-aging (8).

-Natto

Natto is a traditional Japanese fermented soybean product that is produced by the fermentation of soy beans by using Bacillus subtilis. Its high nutritional value, easily digestible and antibacterial characteristics have made it a popular functional food in Japan over the past 400 years. Natto's nutritional benefits are attributed to active compounds such as saponin and isoflavones which originate from the soy bean itself, as well as vitamin K2, dipcolinic acid and fibrinolytic enzymes that are produced by the bacteria present in natto(9). Natto is regarded as a highly nutritional food product as its components act on the human body to improve cardiovascular and bone health. Vitamin K2 promotes bone formation and is suggested to act as prevention against osteoporosis; its concentration significantly increases during the growth stage of Bacillus subtilis. Once bacterial growth comes to an end, layer of poly-γ-glutamic acid is produced and coats the natto providing it with its sticky characteristic. Nattokinase, a potent fibrinolytic enzyme found in natto are known to be responsible for the degradation of blood clots that are associated with heart disease. The dipicolinic acid produced by Bacillus subtilis during fermentation, acts as an antibacterial agent in preventing the growth of Escherichia coli and Helicobacter pylori, therefore promoting gut health (9).

-Sourdough

Sourdough is combination of water and ground cereal containing naturally occurring lactic acid bacteria and yeast. Sourdough fermentation is used in the leavening of bread to produce its characteristic texture and sour flavour. The endogenous microbial community present on the flour will determine the metabolic activity of flour and microbes as well as the factors affecting fermentation such as storage temperature, pH, fermentation time and leavening therefore mature sourdoughs will differ in the microbial diversity as well as metabolic activity. For stability of sourdough production, a mother dough is used to inoculate sourdoughs which allows for the prevalence of dominate lactic acid bacteria such as Lactobacillus sanfranciscensis and Lactobacillus pontis. During fermentation metabolites such as antimicrobial compounds, enzymes as well as exopolysaccharides (EPS) are produced to increase the longevity of bread as well as developing its characteristic texture. EPS is glucose polymer can act as a potential replacement for food additives such as hydrocolloids and is involved in the dough's ability to absorb water. Sourdough is also a good source of probiotics and prebiotics. The cereals

contain starch which can be utilized by probiotic strains for growth, and the prebiotic EPS may act to promote the growth of natural gut flora such as bifidobacteria and lactobacilli (6). Besides being a good source of probiotics and prebiotics, sourdough's health benefits include increased availability of bioactive compounds and minerals as well as inducing a lower glycemic response compared to other baked breads. The lactic acid bacteria present in sourdough also helps with cereal intolerance by peptide hydrolysing toxic peptides and allowing easier digestion, especially for those who suffer from celiac disease (14).

Microorganisms and Functional Foods

-Food Grade

A vast range of microorganisms exist on foods whether from animal or plant sources. These microbes can be naturally present or introduced specifically for the purpose of fermentation. The contamination of microbes is usually associated with the spoilage of foods or even source of food borne illnesses; however some are used in the production of fermented food products such as cheese, sourdough and wine. These food grade microbes are responsible for the characteristic flavour, texture and aroma of the fermented food product and thus are essential in the food production industry. Lactic acid bacteria are one of the most popular microorganisms used in food fermentations. They are gram-positive and non-spore forming microorganisms that produce lactic acid, ethanol, acetic acid and CO2 by fermenting glucose. These microbes are responsible for the production of fermented dairy products, beverages, meat, fruits and vegetables (22).

Acetic acid bacteria are important in the conversion of alcohol into acids through an oxidation process into acetic acid. These bacteria are important in the production of a variety of foods such as vinegar and cocoa however they are also known for the spoilage of several foods and beverages such as beer, wine and fruits (23).

Many types of vinegars exist worldwide and are produced using a variety of materials and fermented via two typical methods, traditional and submerged processes. Traditional methods use acetic acid bacteria that are found in higher oxygen concentrated areas, also known as "surface culture fermentations". The submerged process is more commonly used in the industrial production of vinegar where fermentation is carried out in a semi-continuous fermenter (24). The fermentation of cocoa beans by acetic acid bacteria such as Acetobacter pasteurianus, Acetobacter ghanensis, Acetobacter senegalensis as well as Lactobacillus plantarum and Lactobacillus fermentum is the first step of processing raw cocoa beans to obtain the desired characteristics (25).

-Probiotics

Probiotics are live microorganisms administered as food supplements and exert beneficial effects when ingested in adequate amounts. The health benefits of probiotics include maintaining and improving the balance of intestinal microbes, immunity enhancement, serum cholesterol reduction and even protection from cancer (26). The main strains used for nutritional purposes are lactic acid bacteria, mainly those belonging to the genera Lactococcus and Bifidobacterium. This gram-positive bacteria ferments carbohydrates to produce lactic acid thus play an important role in many dairy products such as cheeses, yogurts and fermented milks. The probiotic activities are strain related thus it is important to identify the bacterial strains in order to determine which strain performs the best and is the most suitable for the intended industrial application (26).

There are certain desirable properties that potential probiotic strains should have in order to exert their beneficial qualities, these include antimicrobial activity against pathogens, resistance against acid and bile to allow oral administration, ability to hydrolyze bile salts as well as the ability to adhere to epithelial and mucosal surfaces (26).

Viability of the probiotic microorganism refers to its ability to survive and grow in the gastrointestinal tract and remain functionally active through processing, packaging and storage. The ability of adhesion means probiotic bacteria are able to survive longer within the gastrointestinal tract and therefore be more effective in its metabolic and immune modulatory actions. Adhesion also provides the extra benefit of competitive exclusion of pathogenic bacteria (27). Probiotic bacteria enhance immune responses improving the function of mucosal barriers as well as providing a safe way of stimulating the immune system development in infants.

Food allergies are adverse immune reactions in response to dietary antigens which causes intestinal inflammation. Probiotics help to alleviate food allergies by acting on the intestinal mucosa to affect antigen transport (26).Food grade microbes are important in extending the shelf life of a variety of foods and are beneficial in the production of

desirable flavors and aromas of many fermented food products. Table 2 illustrates the diverse use of food grade microorganisms in the production of various fermented foods (22).

Table 2. Examples of Food Grade Microorganisms

Microorganism Type	Microorganism	Food/ Beverage	Reference
Bacterium	*Acetobacter pasteurianus*	Chocolate/ Vinegar	(25)
Bacterium	*Acetobacter syzygii*	Chocolate	(25)
Bacterium	*Acetobacter ghanensis*	Chocolate	(25)
Bacterium	*Acetobacter tropicalis*	Chocolate	(25)
Bacterium	*Acetobacter senegalensis*	Chocolate	(25)
Bacterium	*Acetobacter oboediens*	Vinegar	(24)
Bacterium	*Acetobacter pomorum*	Vinegar	(24)
Bacterium	*Acetobacter intermedius*	Vinegar	(24)
Bacterium	*Gluconacetobacter europaeus*	Vinegar	(24)
Bacterium	*Gluconacetobacter entanii*	Vinegar	(24)
Bacterium	*Lactobacillus casei*	Cheese	(28)
Bacterium	*Lactobacillus plantarum*	Cheese/Wine	(28)
Bacterium	*Lactobacillus brevis*	Cheese/Kefir/Wine	(28)
Bacterium	*Lactobacillus buchnerii*	Cheese	(28)
Bacterium	*Lactobacillus rhamnosus*	Cheese	(28)
Bacterium	*Lactobacillus curvatus*	Cheese	(28)
Bacterium	*Lactococcuslactis subsp. lactis*	Kefir	(29)
Bacterium	*Streptococcus thermophilus*	Kefir	(29)
Bacterium	*Lactobacillus delbrueckiisubsp bulgaricus*	Kefir	(29)
Bacterium	*Lactobacillus helveticus*	Kefir	(29)
Bacterium	*Leuconostocoenos*	Wine	(30)
Bacterium	*Pediococcus parvulus*	Wine	(30)
Bacterium	*Pediococcusinopinatus*	Wine	(30)
Bacterium	*Lactobacillus hilgardii*	Wine	(30)
Bacterium	*Lactobacillus fructivorans*	Wine	(30)
Bacterium	*Lactobacillus subtilis*	Soy Sauce, Natto,	(31)
Bacterium	*Leuconostocmesenteroides*	Soy Sauce	(31)

Fungus	*Aspergillus oryzae*	Miso, Sake, Soy Sauce	(31)
Fungus	*Rhizopus arrhizus*	Tempeh	(31)
Fungus	*Aspergillus glaucus*	Fermented Fish	(31)
Fungus	*Rhizopus oligosporus*	Tempeh	(31)
Fungus	*Rhizopu soryzae*	Tempeh	(31)
Bacterium	*Brevibacterium linens*	Cheese	(32)
Fungus	*Debaryomyce shansenii*	Cheese	(32)
Fungus	*Candida zeylanoides*	Cheese	(32)
Fungus	*Yarrowialipolytica*	Cheese	(32)
Fungus	*Kluyveromyceslactis*	Cheese	(32)
Fungus	*Saccharomyces cerevisiae*	Cheese/Bread/Wine/Beer	(32)
Fungus	*Penicillium roqueforti*	Cheese	(32)
Fungus	*Penicillium camemberti*	Cheese/ Sausage	(32)
Fungus	*Aspergillus penicillioides*	Fermented Fish	(32)
Fungus	*Aspergillus wentii*	Fermented Fish	(32)

Future Trends and Prospects

Today functional foods have a large and growing global market and are regarded as one of the most actively researched areas of food science. Functional foods claim to reduce the risk of certain diseases, this can include nutrition-related as well as age-related or degenerative diseases. The increases in healthcare costs due to increased life expectancy, as well as the desire to have an improved quality of life both contribute to the growing interest in foods that can optimize health and reduce preventable dietary diseases.

The marketability and rapid growth in health and wellness products such as functional foods is mainly attributed to the increase in health-consciousness and the phenomena of consumer self-care. The development of such products should be carefully researched to ensure the safety of use, the validity of claims and the right audience is target. The importance of medical and nutritional research on the relationship between diet and health benefits have been further emphasized over the past few decades. Many research institutes, whether academic, private or government based, dedicate a lot of time and effort into extensive research towards identifying how food ingredients can promote and maintain health in hopes of reducing the cost of healthcare and optimizing the quality of life.

Functional foods have a high marketing potential due to the fact that it is a differentiated version of an existing food product which has an additional health value. It is not surprising that many large companies are interested in researching and developing these products just to have the opportunity to claim the benefits on their product labels. The development of novel functional food is a risky and expensive process as it requires thorough research in the product that is being produced or modified as well as the intended target audience for the product.

Many countries don't currently have a legislative definition for the term functional foods and thus it is challenging to distinguish between conventional and functional foods even for professionals in the nutrition and food industries. The definitions vary from country to country, where in Japan functional foods are identified as an individual class of product separate from conventional food and are recognized by the FOSHU symbol displayed on the product labels. Though majority of FOSHU products are in conventional forms, they can also come in the form of tablets or capsules. However in western countries such as USA and countries within Europe, functional foods come in the more conventional

forms and are regarded as a concept, merely the addition of functionality to existing food products and not a separate class of food.

Due to the differences in definitions, different countries will have different regulations in food laws and requirements for the functional food products. For example various rules may be imposed on the newly developed product, including the General Food Law Regulation, and legislations for genetically modified organism (GMO), dietetic food, and supplements may also apply to the functional food products depending on its nature and functionality. Some regulations require the nutrient profiles and the list of authorized claims to be published and made available for the public.

Another important aspect of marketing novel functional food products is considering who the target audience is? There are clear differences in demand for these products amongst different population groups, with the majority of the consumers being from higher income populations, trending more amongst women, married couples and households with children. Also the movement towards fresh and organic foods means that functional foods that are produced through genetic modification are not as easily accepted by consumers.

The perception of functional food products whether negative or positive have been shown to be based more on how nutritious the base product is rather than the advertised health claims. Consumers are more likely to purchase functional food products that are carried by intrinsically healthy and familiar base products such as yogurt, juices and cereals. Though functional foods are presently trending, qualities such as taste and price to quality ratio cannot be overlooked as they are often prioritized over functionality for most consumers.

There has been a general decline in the enthusiasm towards compromising taste for benefit of health thus this is an important aspect to take into consideration when developing a new functional food product.

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