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7. Functional Beverages: A Blend of Taste and Nutrition

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Abstract:

Beverages are one of the most widely used functional foods due to their convenience in packaging and distribution, variety of choice and capability to act as carriers for the essential nutrients and bioactive compounds. Functional beverages are defined as drinks that provide a health benefit beyond basic nutrition. Techniques used in the production of functional beverages include fortification and enrichment, altering a nutrient or the processing method and microencapsulation. Microencapsulation, a popular technology in functional beverage industry, entraps active agents within a carrier material which improves the incorporation of bioactive molecules and living cells into the beverages.

Dairy and non-dairy beverages are the two primary categories of functional beverages. Dairy based beverages are prepared from milk, whey and buttermilk, whereas non-dairy based beverages are from cereals, pulses, millets, fruits, vegetables, tea and coffee. Dairy based functional beverages are made by modifying the fat and protein content of milk, as well as fortifying with fibre, omega 3 fatty acids, phenolic compounds, prebiotics, probiotics, herbs and spices.

There are several forms of whey based beverages, including sports drinks, drinks with fruit juices, drinks with milk and milk products and carbonated whey beverages. Functional beverages based on fruits and vegetables are classified as fermented and non-fermented types. Tea and coffee based beverages are considered functional due to their high phenolic compounds and bioactive compounds including chlorogenic acid, cafestol and kahweol diterpenes. Functional beverages play an essential role in our modern life and contribute to nutritional wellbeing. Sports drinks are one of the most important categories of functional beverages, with the goal of reducing dehydration and maintaining the nutrition of athletes.

Functional beverages also play a role in improving the immune system. Ginger-clove-coffee powder is reported to have anti-microbial, anti-inflammatory and antioxidant property. The drinks with anti-diabetic, anti-hypertensive, anti-cancer and anti-obesity properties have formulated. Functional beverages provide the opportunity for assisting a healthy and active lifestyle, reducing healthcare costs and supporting economic development. Owing to the immense health benefits, increasing consumer demand and choices, there is a huge potential for the development of novel functional beverages.

Keywords:

Nutrition, Functional Beverages, Micro Encapsulation, Dairy Based, Milk Based, Immunity Boosting.

7.1 Introduction:

Food is a term which is basically related to the component necessary for several life sustaining functions like production of energy, supply of nutrients, support of various metabolic activities besides growth and maintenance of the body.

In the early 20th century, nutrition science was engrossed with preventing deficiencies and supporting body growth. During last two decades the knowledge of the dietary influence on health and well-being has been highly increased which has led to design new and healthier foods reducing the risk of several chronic diseases. The foods thus designed are called functional foods which are traditional foods modified in such a way that they have health benefits compared to the non-modified products (Doyon and Labrecque, 2008).

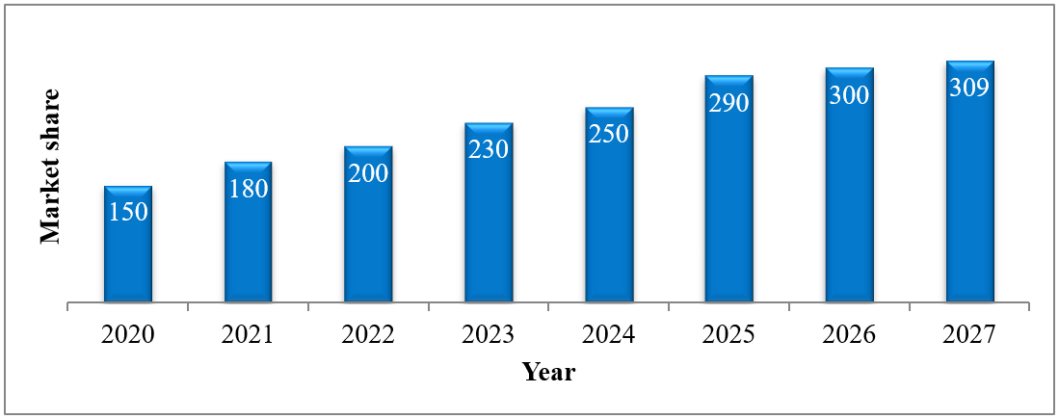

Figure 7.1: Functional food market size 2020-2027 (million dollars)

The functional food market share forecast for the years 2020 to 2027 has clearly shown that there is an increased demand for these functional in the market. In the year 2020 it was 150 million dollars and is estimated that by the year 2027 it may reach a 309 million dollars. We can also see that there are wide varieties of functional foods in the market. The share of dairy products is higher followed by the bakery products.

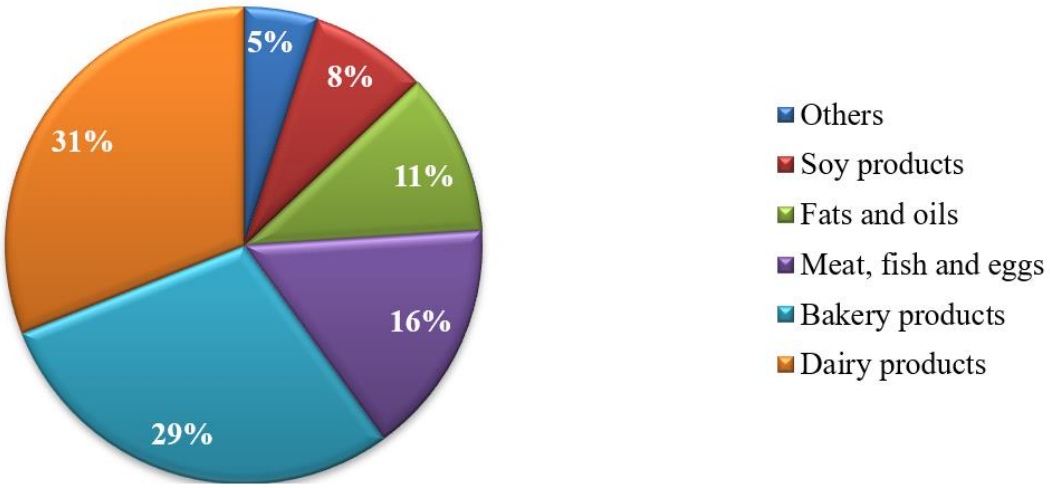

Figure 7.2: Functional food market by product (%)

Beverages are the most active category of functional foods because of their convenience and the ability to meet consumers demand in terms of content size and appearance of the packaging as well as the ease of distribution and storage.

Beverages also represent an excellent medium to incorporate necessary nutrients and bioactive compounds (Global Industries Analyst, 2020).

7.2 Functional Beverages:

In recent times, there has been growing recognition of the key role of foods and beverages in disease prevention and treatment. Thus, the production and consumption of functional foods has gained much importance as they provide a health benefit beyond the basic nutritional functions.

At present, beverages are by far the most active functional food category because of convenience and possibility to meet consumer demands for container contents, size, shape, and appearance, as well as ease of distribution and storage for refrigerated and shelf-stable products.

Moreover, they are an excellent delivering means for nutrients and bioactive compounds including vitamins, minerals, antioxidants, ω-3 fatty acids, plant extracts, and fiber, prebiotics, and probiotics.

However, in most cases, specific concerns have been raised over their safety. A functional beverage is a product that includes ingredients such as herbs, vitamins, minerals, amino acids or additional raw fruit or vegetables (Berner and Donnell, 1998).

Functional beverages are defined as drinks that provide a health benefit beyond basic nutrition (Corbo *et al.,* 2014).

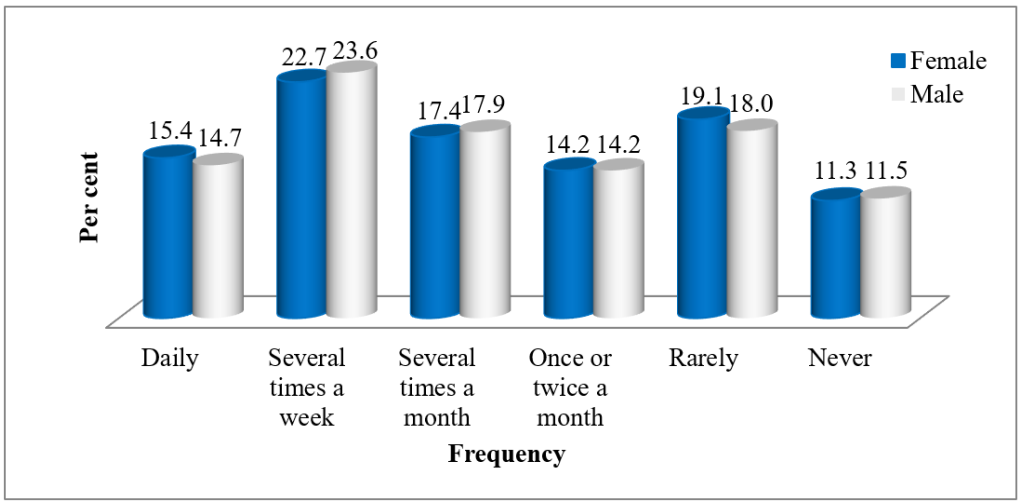

Figure 7.3: Frequency of Consumption of Functional Beverages

In a post covid survey conducted by Natarajan and co-workers in the year 2022 in the state of Tamil Nadu, it was found that 22.7 percentage of females and 23.6 percentage of males had functional beverages several times a week while 15.4 percentage of females and 14.7 percentage of male had functional beverages daily (Natarajan *et al.*, 2022).

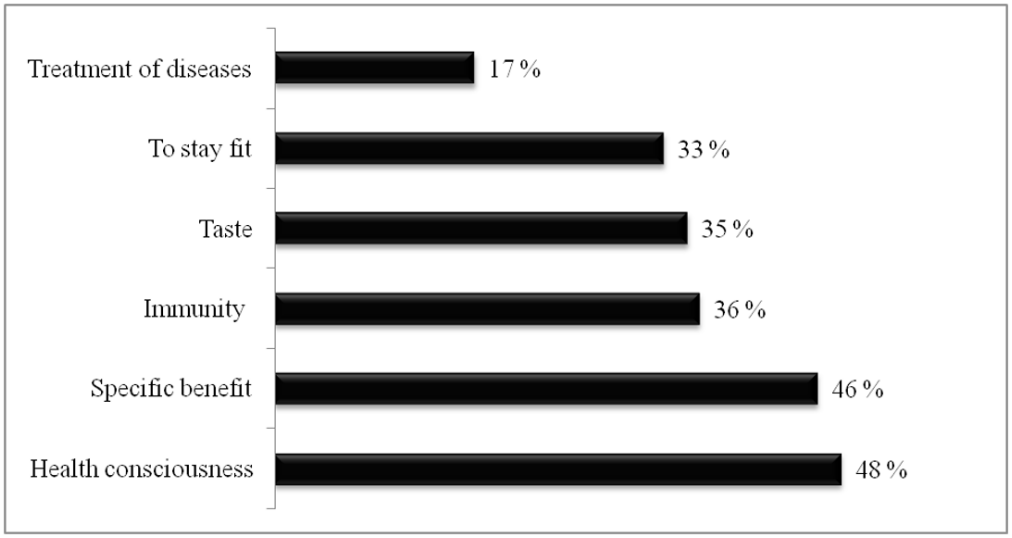

Figure 7.4: Reasons for Consuming Functional Beverages

They have also pointed out the reasons for the increased consumption of functional beverages. it is believed that rise in number of fitness enthusiast and growing consumer's inclination towards healthy lifestyle or expected to do to be the key growth drivers of the function of a wage packet the study also points out the same thing it is said that the persons who had a functional be high rates of functional bridges as due to their health consciousness and 46% of people believe that a specific benefit for these beverages.

7.3 Production Techniques of Functional Beverages:

7.3.1 Fortification or Enrichment:

Fortification is a process wherein we add a specific nutrient to our food to increase its profit new treaty family has all like that here also will add some kind of nutrients or bioactive compounds to the beverages and So that it may be converted to the functional beverages such examples include fortified milk foreign aid and as fortified into the normal milk to improve its nutritive value and Enriched juice wherein it is enriched with certain nutrients lost during its processing enrichment of vitamin c and b etc. Another such example is enhanced water where normal water is enriched with or enhanced with minerals or probiotics, vitamins and much more.

7.3.2 Altering A Nutrient or Processing Method:

By altering the nutrient or the by changing the processing method, certain beneficial factors can be preserved and can benefit in certain health benefits. Alteration of nutrient is seen in skimmed milk wherein the fat is reduced.
The change in processing method like in green tea is another technique wherein the fermentation process is not carried out and that improves the tea's phenolic compounds. Skimmed milk serves the needs of all the consumers who follow or are in need of a low fat diet while the preserved phenolic compounds in the green tea can contribute to various health benefits.

7.3.3 Micro Encapsulation:

A process by which micro- particles or droplets are surrounded by a coating or embedded in a homogeneous or heterogeneous matrix, to give small capsules with many useful properties. This process, suitable to entrap active agents within a carrier material, could be a beneficial tool to enhance the delivery of bioactive compounds and living cells into foods (Tolve *et al.*, 2016).

There are various types of microencapsulation. Some of them include spray and freeze drying, coacervation and microemulsion. In spray and freeze drying, the wall material is mixed with suspension and is evapoured. Another method is coacervation. The latin word *acervus* means heap. This method is mainly used for encapsulating flavors probiotics into beverages. Microemulsion is yet another method which is used for encapsulating bioactive compounds, vitamins, proteins, fatty acids (Sharma and Rathore, 2012).

Functions of micro encapsulation:

- Aroma and flavour stabilization
- Increasing bioavailability and targeted delivery of phenolic compounds
- Increased antioxidant activity
- Shelf life extension
- Protection of valuable nutritious compounds
- Increasing diversity of beverages

Table 7.1: Encapsulation of Probiotics

Functional beverage	Encapsulated micro organisms	Encapsulated technique	References
Grape juice	Lactobacillus casei	Extrusion	Krasaekoopt and Kitsawad, 2010
Carrot juice	L. casei	Spray-drying	Petreska-Ivanovska et al., 2014
Pineapple juice	Bacillus longum	Extrusion	Phoem et al., 2015
Apple juice	Lactobacillus rhamnosus GG	Extrusion	Gandomi et al., 2016

Table 7.2: Encapsulation of Vitamins

Functional beverage	Encapsulated vitamins	Encapsulated technique	References
Orange juice	Vitamin E and vitamin C	Dehydration-rehydration	Marsanasco et al., 2011
Apple juice	Ascorbic acid	Liposomes	Wechtersbach et al., 2012
Orange oil beverage	Vitamin E	Emulsion	Raikos, 2017

7.4 Types of Functional Beverages:

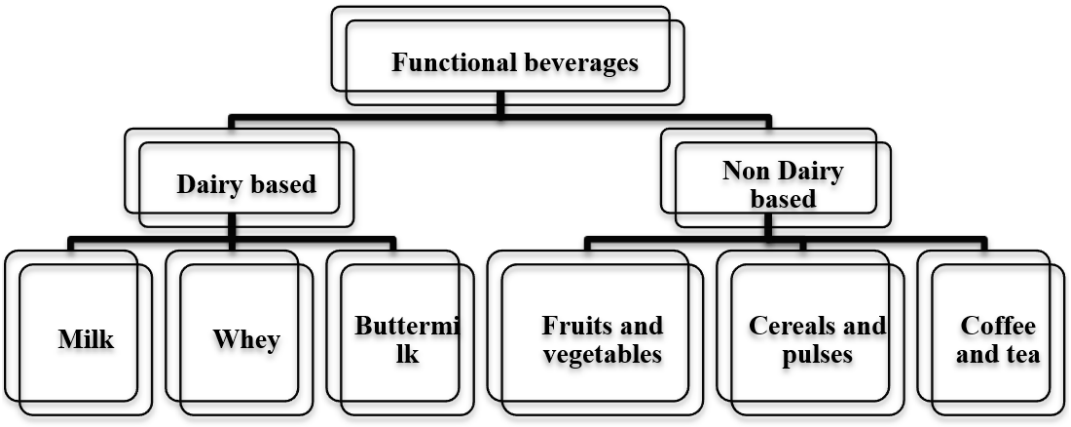

Figure 7.5: Types of Functional Beverages

7.5 Dairy Based:

Dairy based beverages are mainly classified into three milk based, whey based and butter milk based functional beverages (Mudgil and Barak, 2018).

7.5.1 Milk Based:

Milk based beverages can be produced by altering its fat, protein and by fortification. The functionality of normal milk can be improved by the addition of CLA, EPA and DHA into it. These are fatty acids essential for the brain development and brain functioning (Kolanowski and Laufenberg, 2006).

Altering the protein can also improve the functional properties of milk. Enzymatic hydrolysis of protein can result in protein hydrosylates which are bioactive compounds. Apart from this, addition of non-dairy protein sources like millets pulses and egg can also improve the protein content of milk (Makinen *et al*., 2016).

In a study conducted by Lotfia *et al.* (2019), 14% egg white powder was added into the milk to improve its protein quality. The final product was then compared with the normal milk to understand the amino acid content of both and they could find that almost all the amino acids were higher in the final product.

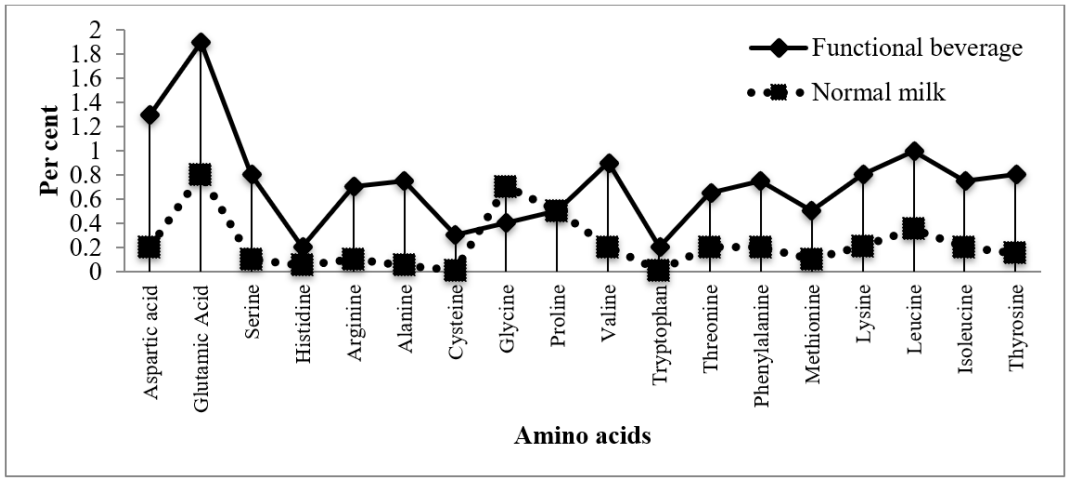

Figure 7.6: Amino Acid Contents in Functional Milk and Normal Milk

Fortification is also another method to improve the quality of beverages. Fortification of milk can be done with vitamins, minerals, fibre, omega 3 fatty acids, phenolic compounds, probiotics, prebiotics, herbs and spices to improve the functionality of milk beverages.

Milk fortified with Vitamin A and D, Calcium flooding in the market can be included under this category (Villegas *et al*., 2010). There are various studies which have undergone to formulate fortified milk beverages. A functional milk was developed by fortifying the normal milk with omega 3 fatty acids from flaxseed oil, phenolic compounds from

phytosetrols and fibre from polydextrose. Fortification of these compounds enhanced the nutritional as well as the therapeutical potential of milk (Nagarajappa and Battula, 2017). Apart from milk, functional yoghurt was formulated with functional ingredients. Johny *et al.* (2021) formulated functional yoghurt with the addition of fruit pulps and functional ingredients.

Fruit pulps of jackfruit, guava, sapota, njalipoovan banana and papaya was added to the yoghurt in the range 10-40 %, in which 10% addition came out best. To this the functional ingredients such as flaxseed and garden cress seed was added to make it a functional yoghurt. Apart from these, herbs can also be added to milk to improve it. Aloe vera pulp was added to milk which on consumption improved the immune system. Addition of betel vine leaf added health benefits such as improved digestion and also it had a high antioxidant property. Fennel, tulsi and lemon grass oil was also fortified to milk. That functional milk helped to decreases the risk of heart disease, it improved eyesight, lowered blood pressure and also it soothes fever, headache and sorethroat.

Table 7.3: Herbal Fortified Milk Beverages

Functional beverage	Herbs	Health benefits	Reference
Milk	Aloe vera pulp	Improved immune system	Pugazhenthi and Jyothilingam, 2013
Milk, yoghurt	Betel vine	Improved digestion, increased antioxidant property	Kamble *et al.*, 2019
Milk, yoghurt	Fennel, tulsi and lemon grass	Decrease the risk of heart diseases, improves eyesight, lowers blood pressure, soothes fever, headache, and sore throat	Kishore *et al.*, 2020

7.5.2 Whey Based:

Whey based milk beverage can be of four types. They are whey based sports drinks, drinks with fruit juice, Drinks with milk and milk products and carbonated whey beverages (Gurakan *et al*., 2009).

A. Whey Based Sports Drinks:

Whey can be efficiently used as sports drinks. After a sport event, the sports personnel will easily get dehydrated. So to overcome that, a rehydrating drink is provided such as ORS. Pushpa *et al.* (2018) formulated a hypotonic rehydration drink by using paneer and cheese whey suitable for sports persons.

All the drinks had electrolytes similar to the recommendation given by WHO for ORS drinks. Hydrolyzing lactose will convert lactose into glucose in whey which made it suitable for even lactose intolerance people.

Table 7.4: Nutritional Comparison of the Hypotonic Drink

Osmolarity (mOsmo/l)					
Constituents	**Untreated whey**		**Lactose hydrolyzed whey**		**WHO formula for ORS drinks**
	Paneer	**Cheese**	**Paneer**	**Cheese**	
Lactose	125.00	133.00	-	-	-
Glucose	-	-	250.00	266.00	75.00
Sodium	14.08	14.35	14.08	14.35	75.00
Potassium	30.94	28.34	30.94	28.34	20.00
Total osmolarity	261.00	232.00	370.00	356.00	245.00

B. Whey Based Drink with Fruit Juices:

Any fruits can be added with whey to improve its flavour, taste and its nutritional property. There are many researches which prove that fruit juices can be incorporated with whey milk to improve its taste and its nutritional quality.

Mango pulp and ginger extract added whey beverage had improved taste and also it had better therapeutical qualities such anti-inflammatory, immunity boosting property (Alane *et al.,* 2017).

C. Whey Based Drink with Milk and Milk Products:

Whey can also be added with the milk and milk products such as yoghurt, sour milk and butter milk to produce functional beverages. According to the product to which whey is added it is classified into unfermented and fermented types (Athanasiadis *et al*., 2004).

D. Carbonated Whey Based Drink:

Carbonated beverages always had a major part in thirst quenching drinks. Probiotic whey is carbonated which have its own functional benefits and at the same time it is thirst quenching. Alves *et al.* (2018) have formulated a probiotic functional drink using the whey.

The probiotic culture used in this study was *Bifidobacterum animalis* subsp. *Lactis* and the product had a viable count of 10^7 to 10^6 till 2 weeks.

7.5.3 Butter Milk Based:

Buttermilk is nothing but the leftover part after butter production. Buttermilk contains more phospholipids than milk because of its high content in milk fat globule membrane material. These phospholipids are having anticarcinogenic properties and also it can protect us from bacterial toxins and also infections.

There are two types of butter milk one is from cultured milk i.e. sour cream and the other from uncultured milk which is sweet cream (Shree *et al*., 2017). Buddhadasa *et al.* (2015) developed a functional beverage based on buttermilk by incorporating soursop pulp, fruit rich in bioactive compounds and having anti-tumorigenic property.

7.6 Non – Dairy Based:

7.6.1 Cereal Based Beverages:

Cereals, apart from being important staple crops and primary sources of energy and nutrition, are replete with bioactive phytochemicals with health properties. Cereal grains contain a diverse range of bioactive phytochemicals including phenolic compounds, dietary fibers, carotenoids, tocols, phytosterols, c-oryzanol, and phytic acid and therefore have great potential for processing into functional beverages.

Although there are a variety of cereal grain-based beverages produced world-wide, very little scientific and technological attention has been paid to them.

In this review, we have discussed cereal grain-based functional beverages based on 3 main categories: cereal grain-based milk alternatives, roasted cereal grain teas, fermented nonalcoholic cereal grain beverages (Xiong *et al.*, 2022).

7.6.2 Pulse Based Beverages:

Over the last decade, plant-based beverages have gained popularity amongst consumers who are seeking alternative and environmentally sustainable options to traditional dairy drinks.

Whilst these days, there is a variety of cereal-based beverages in the market, the legume-based beverage segment is dominated by soy milk products.

There is an opportunity to broaden and diversify this segment into other legumes which may offer better functionality and nutrition than soy.

However, little is known about the processability, functionality, health benefits and associated health risks of legume-based milk substitutes. Apart from soy bean, legumes such chick pea and cow pea can also be used to produce legume based milk substitutes (Nawas *et al.,* 2020).

Soybean milk is a milk alternative beverage due to its inexpensive high-quality vegetable protein. Soybean milk (soybean to water, 1:8 (w/v)) contains an equal amount of protein to a comparable amount of cow's milk but only about one-fifth of the calcium.

Soy milk was fortified with calcium carbonate and tri-calcium phosphate at a similar level of calcium to cow's milk to improve its nutritive quality (Chaiwanon *et al.,* 2000).

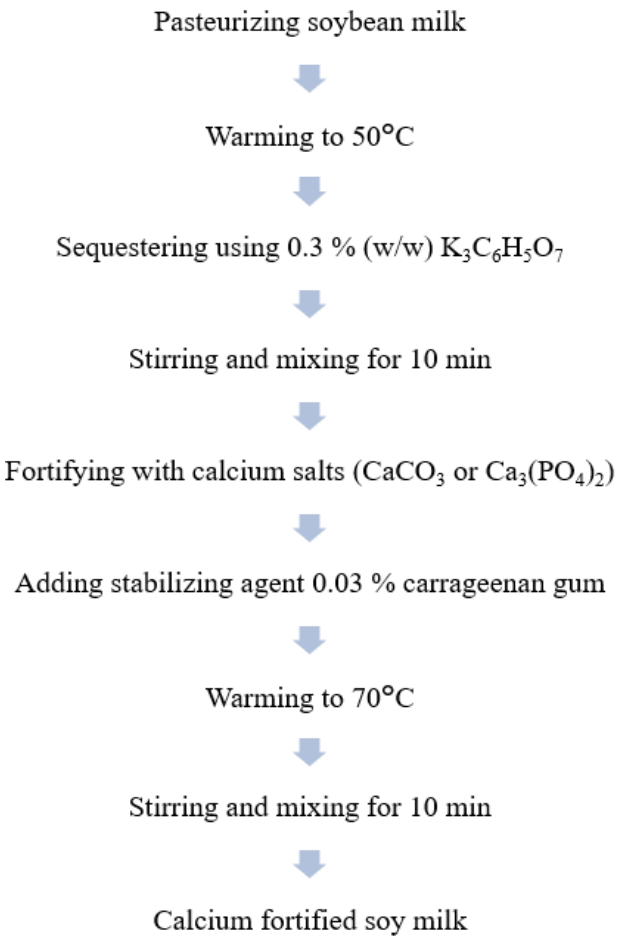

Figure 7.7: Pulse Based Beverages

7.6.3 Fruit/Vegetable Based Beverages:

Functional beverages based on fruits and vegetables are classified as fermented and non-fermented types (Mudgil and Barak, 2018). The functions of food have extended from satisfying hunger and providing nutrients to the body, health maintenance, well-being and prevention of diseases.

Probiotics are such functional foods and when they are incorporated to locally available foods, it helps to improve the nutritional profile and therapeutic value. Probiotic strains were incorporated into locally available fruit juices to improve its nutritive value.

Lactobacillus acidophilus was added to a juice mixture of passion fruit and pineapple (70:30) to develop a probiotic fruit juice (Meera *et al.,* 2021). Fortification of high pressure extracted pomegranate peel extract to carrot juice improved its phenolic content, antioxidant activity and several other beneficial factors in the juice than the normal carrot juice (Trigo *et al.,* 2019).

7.6.4 Tea and Coffee Based Beverages:

Tea and coffee based beverages are considered functional due to their high phenolic compounds and bioactive compounds.

The bioactive compounds seen in tea includes flavanoids, phenolic acids, hydrolysable tannins and that in coffee are chlorogenic acid, cafestol and kahweol diterpenes (Farah, 2009; Heck and Majia, 2009).

Table 7.5: Different Types of Tea/Coffee Based Functional Beverages

Tea / Coffee	Beneficial property	Reference
Green tea	antioxidantanti-inflammatory antimicrobial antimutagenic	Vishnoi *et al.*, 2018
White tea	Cardioprotective antidiabetic, neuroprotective anticarcinogenic antimicrobial antiobesity	Hinojosa-Nogueira *et al.*, 2021
Chrysnthemum tea	antiinflammatory, antipyretic antiarthritic antihypertensive	Li *et al*., 2019b
Fu brick tea	Antiobesity antioxidant	Zhou *et al*., 2021
Date seed coffee	antiinflammatory antidiabetic	Mojrian *et al.*, 2022
Mushroom coffee	anti cholesterolemic	Song, 2020
Green coffee	anti-hypertensive, anti-obesity	Pazmino-Arteaga *et al.*, 2022
Jackfruit seed coffee	anti-diabetic anti-microbial	Spada *et al.*, 2018

7.7 Health and Nutritional Benefits of Functional Beverages:

Functional beverages play an essential role in our modern life and contribute to nutritional wellbeing.

7.7.1 Sports Nutrition:

Sports drinks are one of the most important categories of functional beverages, with the goal of reducing dehydration and maintaining the nutrition of athletes.

It is believed that functional beverages were first confined to sports drinks. They are in need of extra energy which is mainly met by such beverages (Orru *et al.,* 2018).

7.7.2 Immunity Boosting:

Functional beverages also play a role in improving the immune system. Immune boosting beverages are characterized by their high phenolic content, high antioxidant content, hypo allergic property and high micronutrient content (Basak and Gokhale, 2022). Ginger-clove-coffee powder is reported to have anti-microbial, anti-inflammatory and antioxidant property (Lestari *et al.*, 2018). The antioxidant activity of this functional coffee is estimated as 22.42 µg / mL.

7.7.3 Disease Management

The drinks with anti-diabetic, anti-hypertensive, anti-cancer and anti-obesity properties have formulated.

Table 7.6: Different Types of Drinks for Disease Management

	Drinks	Functional properties	Reference
Anti-diabetic drinks	Cashew apple yacon drink	Flavanoid contents, high antioxidant activity, Lowers blood glucose, promotes probiotics, increases catalase enzyme activity in liver	Dionisio *et al.*, 2015
	Quercetin rich guava juice	Quercetin – antioxidant reduces the oxidative damage of pancreas Improves insulin sensitivity	Gayathry and John, 2021
Anti-hypertensive drinks	Fermented milk	Milk (dairy) fermented with lactobacillus bacteria (*Lactobacillus helveticus*), Bioactive peptides	Barrientos *et al*., 2016
	Apocynum tea	Neochlorogenic acid, chlorogenic acid, cryptochlorogenic acid, rutin, isoquercitin, isochlorogenic acid, astragalin	Li *et al*., 2019a
Anti-cancer drinks	Purple basil added drinks	bioactive flavonoids, phenolic and aromatic components, antioxidant activity, anti-inflammatory, anti-tumorigenic	Doguer *et al.*, 2021
	Citrus peel incorporated yoghurt	antioxidant activity phenols in citrus peel – cytotoxicity against human tumor cell lines of colon cancer	Zaki and Naeem, 2021

	Drinks	Functional properties	Reference
Anti-obesity drinks	Papaya seed coffee	Flavonoids, tannins and saponins - inhibitor for pancreatic lipase	Subandi and Nurowidah, 2019
	Kombucha tea	Catechins and flavonoids (theaflavins, theaflavinic acids, thearubigins or theasinensis) hypolipidemic properties	Sinir *et al.*, 2019

7.8 Conclusion:

Functional beverages provide the opportunity for assisting a healthy and active lifestyle, reducing healthcare costs and supporting economic development. Owing to the immense health benefits, increasing consumer demand and choices, there is a huge potential for the development of novel functional beverages.

7.9 References:

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