

# FOOD SCIENCE AND TECHNOLOGY

## Lecture 49

### Lecture 49: Functional and Designer Foods



Hello everybody. Namaste.



In the next 30 minutes or though in this class, we will talk about functional and designer foods or more popularly known as health foods.

## Concepts Covered



- Functional/Health foods
  - ✓ Concept and usefulness
- Categorization of health/functional foods
- Specialized foods and their types
- Synbiotic food & beverages - Case study




So, we will talk briefly what are the health foods, functional foods, what is its concept and usefulness, then what are the various ways by which one can categorize health foods or functional foods, then specialized foods and their types and finally, we will also talk about symbiotic foods and beverages and we take one or two case studies in this regard.

## Health/Functional foods

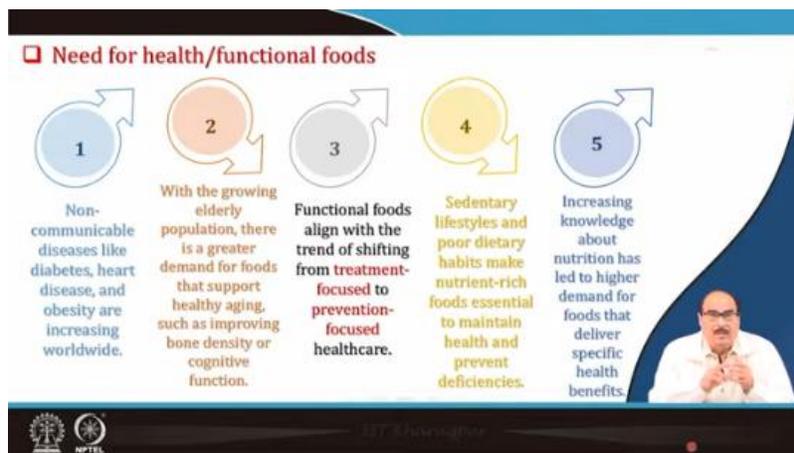
- During the last three decades, the knowledge of the dietary influence on health and wellbeing has been highly increased which has led to design new and healthier foods reducing the risk of several chronic diseases.
- The concept of health foods came in picture in Japan in the 1980s, where these were initially recognized as "Foods for Specified Health Use" (FOSHU).
- The term "health foods" (HF) is commonly used to describe what may be called "functional foods" or "dietary or food supplements."
- These foods were designed to improve public health and reduce healthcare costs by addressing dietary deficiencies and promoting the prevention of chronic diseases.
- Over time, the idea has expanded globally, becoming an integral part of modern nutrition science and health promotion strategies.




You know during the last 3 decades or so, the knowledge of the dietary influence on health and wellbeing has been highly increased, and which has led to design new and healthier foods, reducing the risk of several chronic diseases, and the focus has now shifted that we try to modulate, design, take food in such a way that there are no health problems. So, that is the foods which are this which go beyond the normal nutrition, they provide health benefits are normally called as health foods or functional foods.

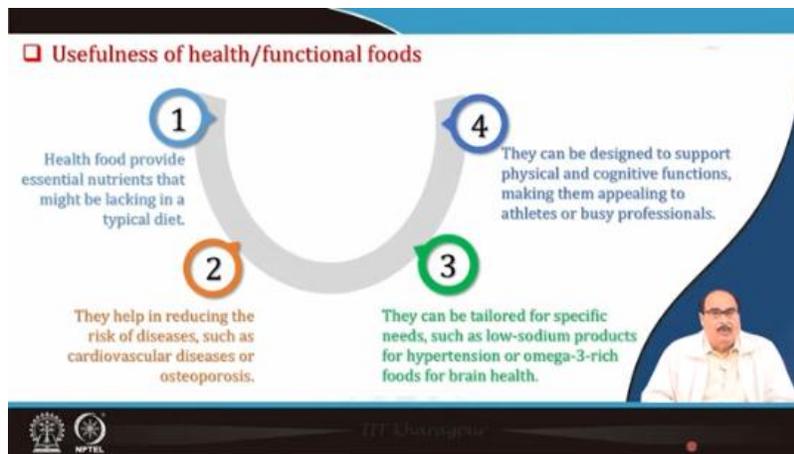
The concept of health foods came in picture in Japan in the early 1980s and where these foods were initially recognized as food for specific health use which is more commonly known as FOSHU. The term health food is commonly used to describe what may be

called health food or functional foods or dietary food or dietary supplement, food supplement and so on why these terminologies are used. So, basically these foods were designed to improve public health and reduce health care cost by addressing dietary deficiencies and promoting the prevention of chronic diseases. Over time, the idea has expanded globally and becoming an integral part of the modern nutritional science and health promotion strategies. Now, health foods are being are pharmaceutical companies is being trickled over by the nutraceutical. Nutraceuticals have become very important components of all pharmaceuticals. Let food be the medicine, and medicine be the food.



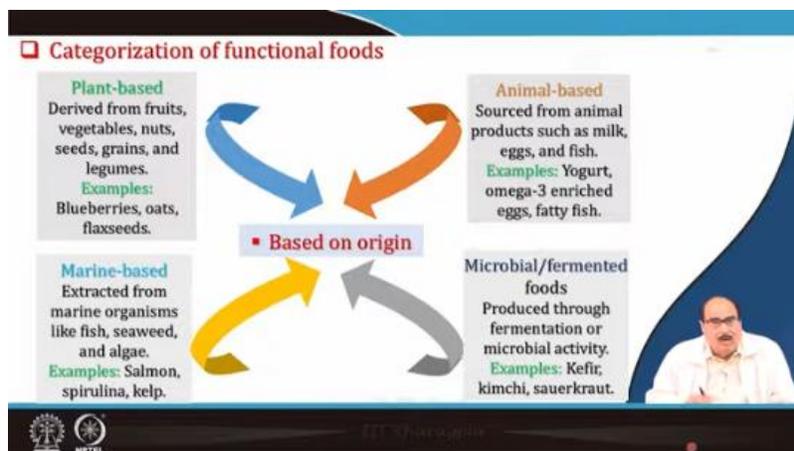
So, there is a need for health or functional foods. Non-communicable diseases like diabetes, heart diseases, and obesity are increasing worldwide. With the growing elderly population, there is a greater demand for food that supports healthy living and healthy ageing, such as improving bone density or cognitive functions. Functional foods align with the trend of shifting from treatment-focused to prevention-focused healthcare.

Earlier, the major focus was that once you are infected and suffering from a disease, you take medicine, that is the treatment focus. But now the focus has shifted to prevention: you regulate your food and water intake in such a way that you do not get these diseases. So, prevention-focused healthcare. Also, sedentary lifestyles and poor dietary habits make nutrient-rich foods essential to maintain health and prevent deficiencies. Increasing knowledge about nutrition has led to higher demand for foods that deliver specific health benefits. So, these are the needs for health foods, etcetera.



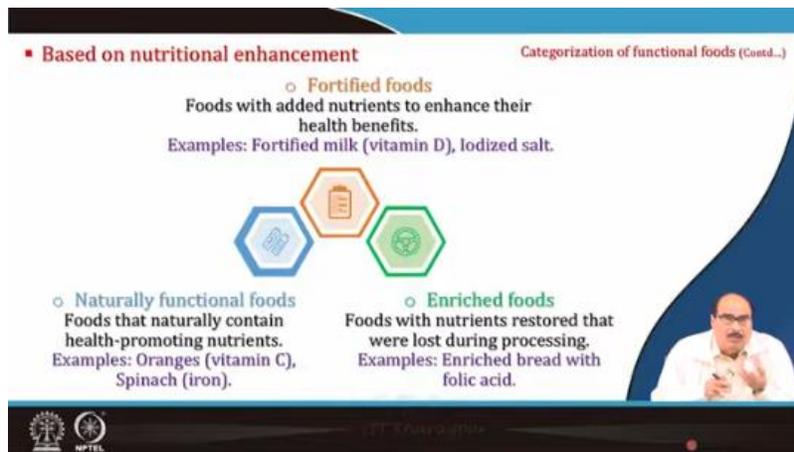
If we talk about the usefulness of health foods. Health foods provide essential nutrients that might be lacking in a typical diet. These nutrients, which are beneficial, may contain antioxidants, bioactives, and other such factors that provide health benefits. These health foods help reduce the risk of various diseases like diabetes, cardiovascular diseases, or even osteoporosis.

They can be tailored for specific needs, such as low-sodium products for people with hypertension or omega-3 rich foods for brain health, and so on. These foods can be designed to support physical and cognitive functions, making them appealing to athletes or other busy professionals, etc. So, these are useful. These health foods provide several advantages; they are useful in various ways.



Now, we will talk about how the categorization or classification of health food can be done. So, one categorization is mainly based on the origin of these foods, what type of ingredients they contain, like plant-based foods derived from fruits, vegetables, grains,

seeds, legumes, etc., such as blueberries, oats, flax seeds, etc. Then, another category may be animal-based sources, such as milk, eggs, fish, etc., like yogurt, omega-3 enriched eggs, fatty acids, and so on. It may be marine-based products, like those extracted from marine organisms such as fish, seaweed, and algae. Examples of this category may include salmon, spirulina, and kelp. Another category may be microbial or fermented foods, which are produced through fermentation or microbial activity. Examples may include kefir, kimchi, sauerkraut, and so on.



Other classifications may be based on nutritional enhancement, such as fortified foods, those with added micronutrients, etc. or nutrients to enhance their health benefits, like fortified milk (with added vitamin D), iodized salt, fortified rice, fortified atta, and so on.

Then, there may be naturally functional foods, those that naturally contain health-promoting ingredients. For example, oranges or other citrus fruits contain vitamin C, and spinach contains iron, which is very helpful in overcoming iron-deficiency anemia.

Then, enriched foods, that is, foods with nutrients are restored that were lost during processing. For example, enriched bread with folic acid or citrus juice concentrates has vitamin C added separately. Vitamin C, which was lost during the concentration process.

So, this is one classification based on nutritional enhancement.



Then, another type of classification may be based on the active components, active health ingredients like prebiotics, probiotics, synbiotics, etc., such as yogurt and banana. It may be antioxidant and bioactive-rich health foods: citrus fruits, curcumin. Fiber and protein-based: oats, whole grain, etcetera. Vitamins and minerals like nuts, fortified foods, then omega-3 fatty acids and plant sterols like salmon, chia, and so on. So, this is another classification: health foods containing specific active compounds.

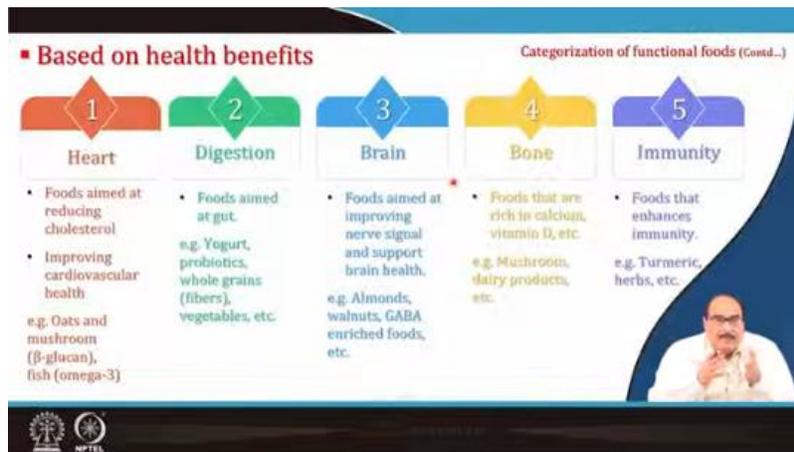


Then, these functional foods are also classified based on the method of processing, like those which are naturally processed or minimally processed foods, natural foods are minimally processed foods, like these foods retain most of their natural nutrients. Minimal or no addition of artificial substances, etcetera, are there. Like, for example, spinach, which contains iron and folate; almonds, which contain vitamin E; oats, which are a good source of fiber; salmon, which has omega-3 fatty acids, etcetera. So, that is, or

cut fruits and vegetables, etcetera, which have antioxidants and all those. So, these are natural or minimally processed foods.

Other categories may include processed foods, but during processing, care is taken by using appropriate methods to modify the ingredients in a suitable way or fortify them for additional health benefits. It may include enrichment with vitamins, minerals, or other active compounds, etc., meaning that processing is done in such a way or during processing, certain health-promoting components are added to the food. Specific examples of this category may include fortified rice, iodized salt, probiotic yogurt, plant-based milk, meat products, and so on.

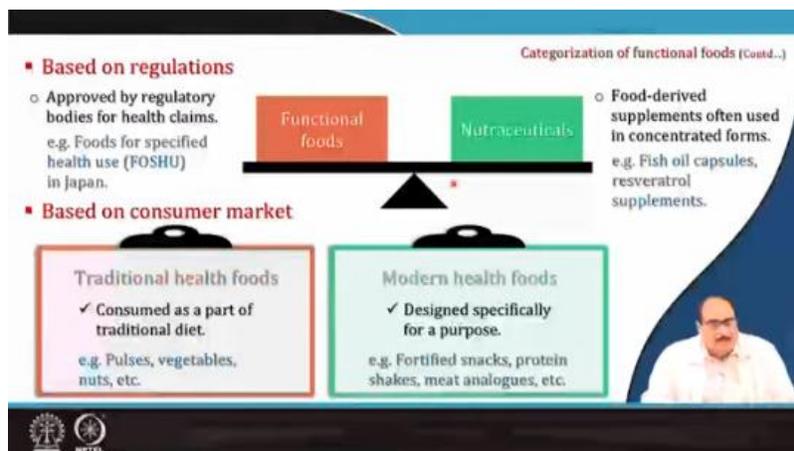
Then, another category may be synthetic or lab-grown foods, which are lab-created or heavily processed foods with added bioactive compounds. They are heavily engineered to target specific health outcomes. For example, fish oil capsules, nutraceuticals, protein bars, lab-grown meat, etc., with specific components. So, these may be classifications of functional foods based on their method of processing.



Now, another very important classification is based on the health benefits they provide. For example, there are heart-healthy functional foods. Heart-healthy foods are aimed at reducing cholesterol levels and improving cardiovascular health. These include oats and mushrooms, which contain beta-glucan, and fish, which has omega-3. These are heart-healthy ingredients. Then there are digestion-targeted foods aimed at improving digestion and gut health, regulating gut microflora, such as yogurt, probiotic yogurt, whole grains, fibers, vegetables, etc.

Then, brain-boosting food, which contains brain-boosting ingredients that improve nerve signals and support brain health, like almonds, walnuts, and even GABA (gamma-aminobutyric acid), which is a neuroprotectant. So, GABA-enriched foods and so on. Then, bone-improving foods, which improve and support bone health, providing better health to bones. These foods are rich in calcium, vitamin D, etc., like mushrooms and dairy products. And then, immunity-boosting foods that enhance immunity, like turmeric, herbs, etc. There are various ingredients, even ascorbic acid and other compounds in fruits and vegetables, which boost a person's immunity.

Such foods were particularly important during the COVID period. So, this is the classification of health foods and their health benefits.



These foods are also classified based on regulations. Functional foods are approved by regulatory bodies for health claims, like Foods for Specified Health Uses (FOSHU) in Japan, or they may be nutraceuticals, like food-derived supplements often used in concentrated forms, such as fish oil capsules, resveratrol supplements, and so on.

These foods can also be classified based on the consumer market. For example, traditional health foods, which are consumed as part of a traditional diet, like pulses, vegetables, nuts, etc., or modern health foods, which are designed specifically for a purpose, like fortified snacks, protein shakes, meat analogues, and so on.

## Specialized foods

- Specialized foods are the foods that are designed for a specific purpose to meet specific dietary requirements for a specific group of people.
- They are often designed to improve the nutritional intake of the people we assist around the world.
- They go beyond regular dietary needs, offering specific nutrients, bioactive components, or functionality to support health, enhance performance, or manage medical conditions.
- Examples
  - ✓ Ready-to-use therapeutic foods
  - ✓ Ready-to-use supplementary foods
  - ✓ Fortified blended foods
  - ✓ Lipid-based nutrient supplements
  - ✓ Vitamin & mineral powder
  - ✓ High energy biscuit
  - ✓ Fortified rice kernels
  - ✓ Compressed food bars




Now, let us talk about specialized foods, particularly functional foods, which are designed for specific purposes. Specialized foods are designed for a specific purpose to meet the dietary requirements of a specific group of people. They are often designated or designed to improve the nutritional intake of the people we assist around the world. They go beyond regular dietary needs, offering specific nutrients, bioactive components, or functionality to support health, enhance performance, or manage medical conditions.

There are several examples of these foods, like ready-to-eat therapeutic food, which is designed particularly for severely acute malnourished children (SAM children). Ready-to-eat supplementary foods, fortified blended foods, lipid-based nutrient supplements, vitamin and mineral powders, high-energy biscuits, fortified rice kernels, which are normally aimed at reducing iron deficiency anemia, or compressed food bars, etcetera, maybe protein bars or others that are health-promoting factors for sports persons or other individuals; these can be designed.

## Types of specialized foods

### 01 Based on health conditions

#### Medicinal foods

- ◆ Foods designed for individuals with specific medical conditions.

#### Examples

- ✓ Diabetes: Low-glycemic foods, sugar-free snacks, etc.
- ✓ Hypertension: Low-sodium foods, etc.
- ✓ Celiac disease: Gluten-free foods like gluten-free bread, pasta, and baked goods.
- ✓ Heart disease: Cholesterol reduction foods like oats ( $\beta$ -glucan), fatty fish (omega-3-rich).
- ✓ Kidney disorders: Low-potassium foods.




Now, let us talk about the types of specialized foods, that is, types. The first type may be based on health conditions, like medicinal foods, which are designed for individuals with specific medical conditions. For example, for diabetic people, it may be low-glycemic foods, sugar-free snacks, etcetera; for hypertension, low-sodium foods. For celiac disease patients, gluten-free foods like gluten-free bread, gluten-free pasta, or other gluten-free baked goods, meaning there is no wheat in those products. For heart disease, i.e., for controlling heart disease, cholesterol-reducing foods like oats, which contain beta-glucan, or fatty fish, which contain a high amount of omega-3 fatty acids; and then kidney disorder foods, which can improve kidney disorders or prevent kidney failures, etcetera, like low-potassium foods and so on. So, you can say these are the medicinal foods.

**Types of specialized foods**

**01** Based on health conditions

**Allergen-free foods**

- ❖ Foods designed for individuals having allergies or intolerance.

**Examples**

- ✓ Dairy allergens: Dairy-free alternatives like plant-based milk, cheese, etc.
- ✓ Soy allergen: Soy-free products.
- ✓ Nuts allergen: Nut-free snacks, etc.
- ✓ Gluten intolerance.

**9 MAJOR FOOD ALLERGENS**

Top allergen foods

Then there may be allergen-free foods. These foods are designed for individuals with allergens or imbalances, a person may be allergic to a particular component. So, those are taken care here like dairy allergens. So, many people those who are allergens to dairy component there are dairy free alternatives like even plant-based milk etcetera. There is person particularly who have the lactose intolerance and such other allergies with them, they can take plant-based milk. They can take other plant-based vegetable, cheeses etcetera. Then there are soya allergens, many peoples are allergic to soya products.

So, for them soya free products, nuts allergens. So, accordingly nut free snacks etcetera. To take care of gluten intolerance, there are many foods, gluten free foods. So, these are the allergen free foods.

**Types of specialized foods**

**02 Based on lifestyle**

**Vegan and vegetarian foods**

- ❖ Foods designed for individuals who prefer plant-based foods.

**Examples**

- ✓ Plant-based meat alternatives (soy, pea, wheat, mycelium etc.)
- ✓ Plant-based milk alternatives (oats, soy, etc.)
- ✓ Plant-based egg (starch and proteins, soy products, algae, etc.)
- ✓ Plant-based cheese, yogurt.
- ✓ Vegan protein powders

**Plant-based meat**




**NPTL**

Then, the other category of the specialized foods may be for that they can be formulated and designed, then those are categorization may be based on lifestyle that is the lifestyle of the person. So, accordingly it may be a vegan food or and vegetarian foods.

These vegan and vegetarian foods are designed for individuals who prefer plant-based foods. Plant-based meat alternatives like those which are prepared from soya, pea, wheat, mycelium etcetera. Plant-based milk alternatives like oat milk, soya milk, peanut milk, ground almond milk and so on. Plant-based egg that is starch and protein, soya protein, algae etcetera is used for making egg-like products. Plant based cheese or yogurt or vegan protein powders and so on.

There are that is grain powders and all those things which can be protein powder which can be made from the plant sources. So, these are the various vegan and vegetarian foods.

**Types of specialized foods**

**02 Based on lifestyle**

**Ketogenic foods**

- ❖ Foods designed for individuals who prefer low-carbs and high fats.

**Examples**

- ✓ Keto-friendly snacks (nuts, seeds, etc.)
- ✓ Low-carb bread
- ✓ Coconut oil.
- ✓ Keto ice cream, etc.

**Keto vs Regular ice cream**

Source: Cheatdaydesign.com

Nutrition Facts	
	100g
Energy	2000
Total Fat	20g
Total Carbohydrate	20g
Total Protein	20g
Sodium	20g
Cholesterol	20g
Dietary Fiber	20g
Sugars	20g
Protein	20g
Calcium	20g
Iron	20g
Vitamin A	20g
Vitamin C	20g
Vitamin D	20g
Vitamin E	20g
Vitamin K	20g
Thiamin	20g
Riboflavin	20g
Niacin	20g
Vitamin B6	20g
Folate	20g
Vitamin B12	20g
Potassium	20g
Magnesium	20g
Phosphorus	20g
Zinc	20g
Copper	20g
Manganese	20g
Selenium	20g
Chromium	20g
Molybdenum	20g

**Keto friendly very berry**




**NPTL**

Source: getawayinsiders.com

Then there may be also the food based on lifestyle will be ketogenic foods. That are the foods which are designed for individuals who prefer low carb and high fat foods. These

are the ketogenic foods like keto friendly snacks, nuts, seeds, etcetera, low carb bread, coconut oil, keto ice creams etcetera. You can see that is one keto friendly very very where the carbohydrate added sugar is 0. Total carbohydrate may be 5.5 gram, but total fat is around 18 gram etcetera. Similarly, keto versus regular ice cream you can say the difference in the fat. In the regular ice cream fat may be 5 grams whereas, the keto it may be 18 grams. Sugars here less than 1 gram, here sugar is more 15 grams. So, that is the ketogenic foods.

**Types of specialized foods**

**02 Based on lifestyle**

**Organic and natural foods**

- ❖ Natural food is frequently assumed to suggest foods that are minimally processed and all ingredients are derived from natural products. However, natural foods are not regulated by the food system.
- ❖ Organic foods are products of holistic agricultural practices focusing on biodiversity, soil health, chemical free inputs, etc. with an environmentally and socially responsible approach that have been produced in accordance with organic production standards.

✓ All organic foods are categorized as natural foods, but all natural foods cannot be categorized as organic foods.

Logos: Jaivik Bharat, National Programme on Organic Production, USDA ORGANIC

Then other may be organic and natural foods. Natural food is frequently assumed to suggest foods that are minimally processed and are All ingredients are derived from natural products. However, natural foods are not regulated by the food systems.

Organic foods are products of holistic agricultural practices focusing on biodiversity, soil health, chemical-free inputs, etc., with an environmentally and socially responsible approach. They have been produced in accordance with organic production standards. You should know that all organic foods are categorized as natural foods, but not all-natural foods may be categorized as organic foods.

**Types of specialized foods**

❖ The unique nutritional needs of different lifestyles require tailored diets and specialized foods.

**02 Based on lifestyle**

Army personnel's

Sports and athletes

Hikers & adventurers

Gym personnel's

Intermittent fasting individuals

Office workers

Yoga practitioners

Other foods are based on lifestyle, like the unique nutritional needs of different lifestyles, which require tailored diets and specialized foods. Examples include foods for army personnel, hikers, adventurers, gym-goers, intermittent fasting individuals, sports foods for athletes, and foods for office workers. Foods for yoga practitioners are also important because these individuals engage in specific activities. Their activity levels are different. Therefore, their nutritional requirements also differ, and accordingly, one can design specific foods for these specific people and activities. Let us consider yoga practitioners.

**Yoga practitioners**

- Yoga practitioners engage in activities that promote flexibility, mindfulness, and moderate physical exertion.
- Focus on mind-body harmony.

**Goal**

- Boost energy with light, easily digestible foods.
- Support hydration and mental clarity.
- Promote anti-inflammatory benefits for flexibility and joint health.

**Examples**

- Fruits, vegetables
- Plant-based proteins
- Herbal tea (Ashwagandha, turmeric tea)
- Nuts, coconuts, chia seeds, etc.

**Specialized foods (Contd..)**

20g carbohydrates

1g sugar

3-4g fiber

Atlas bars

Yoga practitioners engage in activities that promote flexibility, mindfulness, and moderate physical exertion. Here, the focus is on mind-body harmony. When designing food for a yoga practitioner, the objective should be to boost energy with light, easily digestible foods. It should support hydration and mental clarity. It should also promote anti-inflammatory benefits for flexibility and joint health. Examples include fruits, vegetables, plant-based proteins, herbal teas, such as ashwagandha, turmeric tea, nuts,

coconuts, chia seeds, and so on. And there may be atlas bars for yoga practitioners, which have different contents like 1-gram natural sugar, 3 grams net carbs, or 20 grams quality proteins, etcetera. These may be from Element or other sources.

Specialized foods (Contd..)

▪ **Gym person**

- Gym personnel's engage in activities focusing on strength, and cardiovascular diseases.
- Focus on muscle build, fat loss, and stamina.

**Goal**

- ✓ High protein intake for muscle repair and growth.
- ✓ Adequate carbohydrates for glycogen replenishment.
- ✓ Hydration and electrolytes to prevent dehydration.

**Examples**

- ✓ Protein powders
- ✓ Healthy oil (olive oil)
- ✓ Chicken, egg, etc.
- ✓ Banana, nuts, berries, etc.

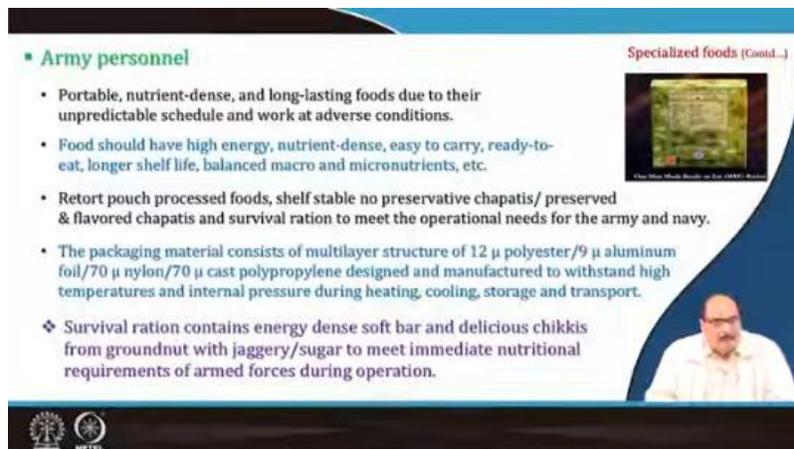


Similarly, the food for gym-goers, you know, gym personnel engage in activities focusing on strength and cardiovascular fitness. So, the focus is on muscle building, fat loss, and stamina. So, the objective or goal of such food is that it should provide high protein intake for muscle repair and growth. There should be adequate carbohydrates for glycogen replacement, as well as hydration and electrolytes to prevent dehydration, especially for gym-goers. So, food examples include protein powders, healthy oils like olive oil, chicken, eggs, bananas, nuts, berries, and so on.

Specialized foods (Contd..)

▪ **Army personnel**

- Portable, nutrient-dense, and long-lasting foods due to their unpredictable schedule and work at adverse conditions.
- Food should have high energy, nutrient-dense, easy to carry, ready-to-eat, longer shelf life, balanced macro and micronutrients, etc.
- Retort pouch processed foods, shelf stable no preservative chapatis/ preserved & flavored chapatis and survival ration to meet the operational needs for the army and navy.
- The packaging material consists of multilayer structure of 12  $\mu$  polyester/9  $\mu$  aluminum foil/70  $\mu$  nylon/70  $\mu$  cast polypropylene designed and manufactured to withstand high temperatures and internal pressure during heating, cooling, storage and transport.
- ❖ Survival ration contains energy dense soft bar and delicious chikkis from groundnut with jaggery/sugar to meet immediate nutritional requirements of armed forces during operation.



Then, for army personnel, the food should be portable, nutrient-dense, and long-lasting due to their unpredictable schedules and work in adverse conditions. These army personnel are required to work under very extreme and hard conditions. So, the food

should be very high in energy, nutrient-dense, easy to carry, ready to eat, have a longer shelf life, and contain balanced macro and micronutrients, etcetera, as required for army personnel.

So, retort pouch processed foods, shelf-stable foods with no preservatives or preservative-free chapatis, preserved and flavored chapatis, and several survival rations are needed to meet the operational needs of the army and navy. These materials should also be properly packaged. The packaging material may consist of a multilayer structure of 12-micron polyester or 9-micron aluminum foil, 70-micron nylon or 70-micron cast polypropylene, which is designed and manufactured to withstand high temperatures and internal pressure during heating, cooling, storage, and transport. And the survival rations contain energy-dense soft bars and delicious chikkis made from groundnuts with jaggery, sugar, etcetera, to meet the immediate nutritional requirements of armed forces during operations.

So, so this type of care should be taken for designing the food for army people.

**Specialized foods (Contd..)**

**The ATHLETE'S FOOD PYRAMID**

TIER 5: SUPPLEMENTS  
TIER 4: SPORT FUEL  
TIER 3: NUTRIMENT TIMING  
TIER 2: MICRONUTRIENTS  
TIER 1: HIGH-QUALITY WHOLE FOODS

**Examples**

- ✓ Energy gels
- ✓ Protein bars etc.

**■ Athletes**

- Individuals engaged in competitive sports requiring peak physical performance.
- Foods tailored to specific sports (e.g., endurance, strength, or agility).

**Nutritional requirements**

- ✓ Carbohydrates: 6–10 g/kg body weight for endurance and glycogen storage.
- ✓ Protein: 1.2–2.0 g/kg for muscle repair and growth.
- ✓ Electrolytes: Replenish minerals lost through sweat.
- ✓ Antioxidants: Reduce oxidative stress from high-intensity activity.

Source: <https://report360.com/food-pyramid-guide/>

Similarly, for athletes that individual which are engaged in competitive sports requiring peak physical performance. Foods tailored to a specific sport like endurance, strength, agility etcetera. The nutritional requirement for athletes may be the carbohydrates in the range of 6 to 10 gram per kg body weight for endurance and glycogen storage. They might require protein in the range of 1.2 to 2 gram per kg body weight for muscle repair and growth, even sufficient amount of electrolytes to replenish the minerals which are lost through excessive sweating during this their work, then it should have sufficient

amount of antioxidants that reduces oxidative stress from high intense activity. So, here the foods developed with these on focus are may be energy gels, protein bars etcetera. And you can see that the athlete's food pyramid that tier 1 you give high quality whole foods, tier 2 micronutrients, tier 3 nutrient timings, then sports fuel and finally, supplements these are the some.

**Types of specialized foods**

**03 Based on age**

**Infant and toddlers**

- ✓ Foods designed to support growth and development in young children.
- ✓ Specifically for brain and immune system.
- ✦ High levels of iron, calcium, vitamin D, and DHA for brain and bone development.

**Examples**

- ✦ Gerber organic baby cereal

A fortified cereal enriched with iron and DHA to support brain development.




Then then type of specialized food it may be based on the age another category of the specialized food which can be designed and for a particular age group people like those for the infants and toddlers, their food should support the growth and development in young children, especially for brain and immune system. They should have high level of iron, calcium, vitamin D and DHA for brain and bone development. An example of such foods may be Gerber organic baby cereal, a fortified cereal enriched with iron and DHA to support brain development and so on. There are many foods, such food is available in the market which are especially designed for infant and toddlers.

**Types of specialized foods**

**03 Based on age**

**Child and adolescents**

- ✓ They require nutrient-dense foods to support growth spurts, hormonal changes, and physical activity.



	MALE			FEMALE		
	10-12 Yr	13-15 Yr	16-18 Yr	10-12 Yr	13-15 Yr	16-18 Yr
Energy (Kcal)	2200	2550	2700	2000	2100	2100
Protein (gms)	54	70	78	57	65	63
Calcium (Mg)	500	600	500	600	800	500
Iron (Mg)	34	41	50	19	28	30



Source: en.wikipedia.in

Then the food for child and adolescents like they require nutrient dense foods to support growth spurts, hormonal changes and physical activities, and there are recommended dietary allowances for male, female, for adults and infants that are provided by the agencies. In India it is by NIN National Institute of Nutrition. So, those requirements should be taken into account, consideration while designing the food for such classes of people for even child and adults and boys, girls, male, female so on.

**Types of specialized foods**

**03 Based on age**

**Adult**

- ✓ Adults require foods that maintain energy levels, prevent chronic diseases, and support overall health.

**Examples**

- ✓ Heart-healthy foods (e.g., oats, fatty fish).
- ✓ Probiotic and prebiotic foods for gut health.
- ✓ Foods enriched with antioxidants for overall well-being.




NPTEL

For adults like adults require foods that maintain energy levels, prevent chronic diseases and support overall health like heart healthy foods, oat fatty face, probiotic and prebiotic foods for gut health, foods enriched with antioxidants for overall wellbeing etcetera. So, this may be food for adult.

**Types of specialized foods**

**03 Based on age**

**Elderly people**

- ✓ Older people require foods that prevent nutrient deficiencies, support bone health, and combat muscle loss (sarcopenia).
- ✓ Proteins to combat muscle loss and promote repair.
- ✓ High calcium and vitamin D rich food for bone density and osteoporosis.
- ✓ Food that improve digestion (vegetables for fiber).
- ✓ Omega-3 rich foods for heart and brain.

**The Food Pyramid For older adults**

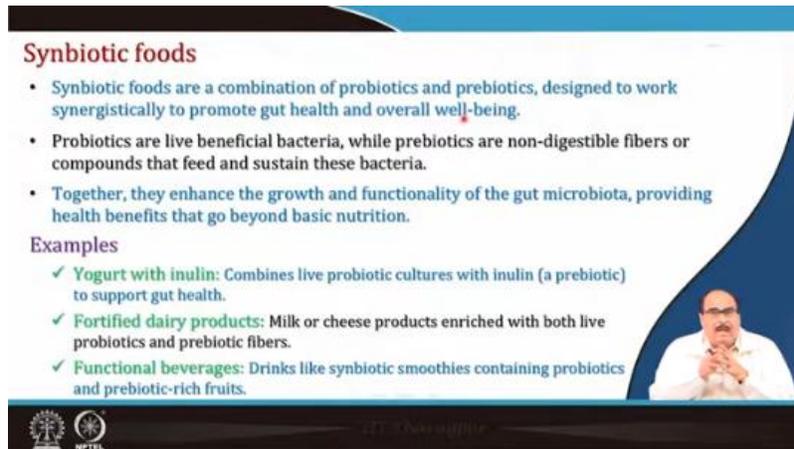
Foods and drinks high in fat, sugar and salt	1
Fats, spreads and oils	2-3
Meat, poultry, fish, eggs, beans and nuts	2-3
Milk, yogurt and cheese	3-4
Wholemeal cereals and breads, potatoes, pasta and rice	3-5
Vegetables, salad and fruit	3-5



NPTEL

The food for elderly people like older people requires foods that prevent nutrient deficiencies, support bone health and combat muscles loss like sarcopenia etcetera. So, the protein to combat muscle loss and promote repair, it should contain high calcium and

vitamin D rich foods for bone density and osteoporosis. The foods that improve digestion like vegetables and fibers etcetera are omega-3 rich foods for heart and brain health. So, accordingly that the requirement of elderly people can be made by taking these points into consideration. Now, let us talk about synbiotic foods.



**Synbiotic foods**

- Synbiotic foods are a combination of probiotics and prebiotics, designed to work synergistically to promote gut health and overall well-being.
- Probiotics are live beneficial bacteria, while prebiotics are non-digestible fibers or compounds that feed and sustain these bacteria.
- Together, they enhance the growth and functionality of the gut microbiota, providing health benefits that go beyond basic nutrition.

**Examples**

- ✓ **Yogurt with inulin:** Combines live probiotic cultures with inulin (a prebiotic) to support gut health.
- ✓ **Fortified dairy products:** Milk or cheese products enriched with both live probiotics and prebiotic fibers.
- ✓ **Functional beverages:** Drinks like synbiotic smoothies containing probiotics and prebiotic-rich fruits.

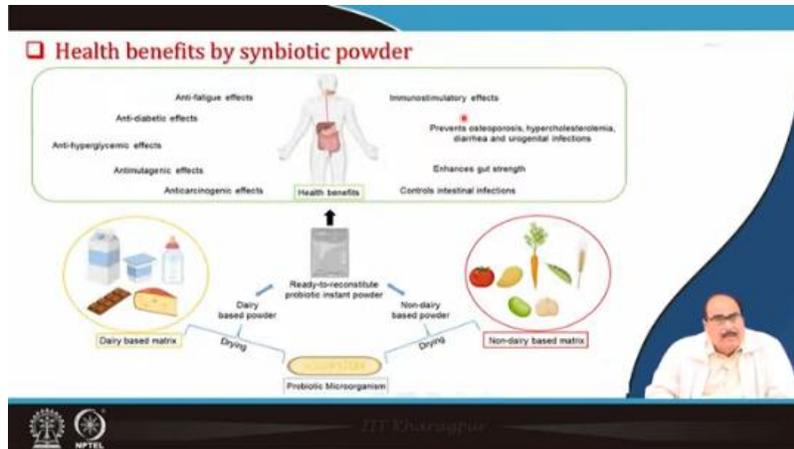
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What is the synbiotic foods? Synbiotic is a combination of probiotic and prebiotic. So, the synbiotic foods means which contain both a probiotic and prebiotic together and this is designed to work synergistically to promote the gut health and overall well being. In the earlier classes, we discussed about that what is the gut health and how this gut health are regulated by the probiotic microorganism or such other health protein microorganisms or some microbiota. So, the probiotics particularly they are the live beneficial bacteria which provide several health benefits and which improve our gut modulate gut functions.

Whereas, the prebiotics, it is difference between O and E. So, probiotics is a bacteria, live bacteria like there are several lactic acid bacteria lactobacillus plantarum and there are so many large list is there by probiotic bacteria. And then the prebiotic is a non-digestible fiber or oligosaccharides or compounds that are required by these bacteria to survive. So, they are basically the food for probiotics. So, the bacteria, live bacteria and their food they are prepared together, they are kept together in the suitable system that you can say is a synbiotic foods.

Together they enhance the growth and functionality of the gut microbiota providing health benefits that go beyond basic nutrition. So, the examples of symbiotic foods may

be yogu with inulin, that is it combines live probiotic culture with inulin that is a prebiotic to support the growth. So, the same it has a microbial culture also it has been prebiotic and it has been probiotic bacteria. Then fortified dairy products like milk or cheese products enriched with both live probiotics and prebiotic fibers. Functional beverages like drinks and synbiotic smoothies containing probiotics and prebiotic rich food, fruits, etc.



Then, the how that what is the health benefits by this synbiotic powder, synbiotic foods etcetera. we had discussed earlier etcetera like probiotic microorganism, then may be a dairy-based food matrix. So, by suitable processing technology, in this case, drying you can have a dry dairy-based powder or non-dairy based powder and then these two, that probiotic powder may be ready to reconstitute probiotic instant powder you can prepare, and these can be suitably it can be eaten and it regulates the various function that is control intestinal infections, enhances gut strength, it is immunostimulatory effect it has.

It prevents osteoporosis, hypercholesterolemia, diarrhea, urogenital infections, etcetera, antimicrobial mutagenic effects, and anti-carcinogenic effects. So, it has various health benefits.

Let us say that we have one or two case studies; one case study is a probiotic vegetable beverage with anti-diabetic potential. Earlier, it was a concept that these probiotic bacteria find milk or dairy products as suitable substrates for their growth, but we also worked on non-dairy products like fruit juices. Well, vegetable juices, different vegetable juices like bottle gourd juice, carrot juice, and bitter gourd juice.

### Case study 1 : Probiotic vegetable beverage with anti diabetic potential

- Vegetable based synbiotic beverage offers a healthy alternative for milk based probiotic and provides the benefits of vitamins, minerals, antioxidants and other bioactive.

- Optimum parameter values for the logistic model describing the growth of *L. plantarum* in MRS broth and vegetable juice at 37 °C for 24 h.

	$\mu$ (h <sup>-1</sup> )	$\lambda$ (h)	A	R <sup>2</sup>	F-value	Data points
MRS broth	0.62 ± 0.02	3.06	3.81	0.99	4602.86	13
Vegetable juice	0.53 ± 0.02	2.72	3.07	0.988	319.448	10

These juices were taken in different proportions. They were added with certain other ingredients to support microbial growth, like some other polysaccharides or such materials which required the growth factor. And then the organism is inoculated with *L. plantarum* and other probiotic bacteria, and their growth characteristics were studied in various conditions, like they were allowed to grow in the MRS growth medium as well as in the vegetable juice mixed in a proper proportion. And you can see the growth characteristics MRS and other factor equations are very similar.

This means that the microorganism grew in this, and you get a probiotic vegetable juice, meaning that this vegetable juice has live bacteria in it, but there is no alcohol fermentation. Non-alcoholic probiotic bacteria with the fermentation process inoculated. And this was developed by us, and it is a very good probiotic vegetable beverage with antibiotic potential and anti-diabetic potential because bitter melon juice, carrot juice, and bottle gourd juice are all known for these properties. So, it regulates both functions.

### Case study 2 : Synbiotic functional bar with LAB and GABA

So, another food was developed, like a synbiotic functional bar with lactic acid bacteria and GABA, which was another project. One of my PhD scholars, or rather two PhD scholars, worked on it. GABA is gamma-aminobutyric acid, you know. It is a neuroprotectant. So, what we thought was that lactic acid bacteria, which are probiotic, produce it. So, the lactic acid bacteria strain, lactase, and then GABA in suitable proportions were taken, and with wall material, certain wall materials like dextrose, inulin, and such other components.

They were all taken together and added with some water, etcetera, distilled water, and converted into a form of emulsion. And this emulsion basically has 20 percent total soluble solids and core-to-wall material, where the core here is the probiotic bacteria and GABA. So, the core and wall material proportion were maintained at a ratio of 1:2. And then these were co-encapsulated by spray drying. And the inlet air conditions were  $110 \pm 2$  °C for spray drying, the outlet temperature was  $50 \pm 3$  °C, and the flow rate was maintained at 5 milliliters per minute.

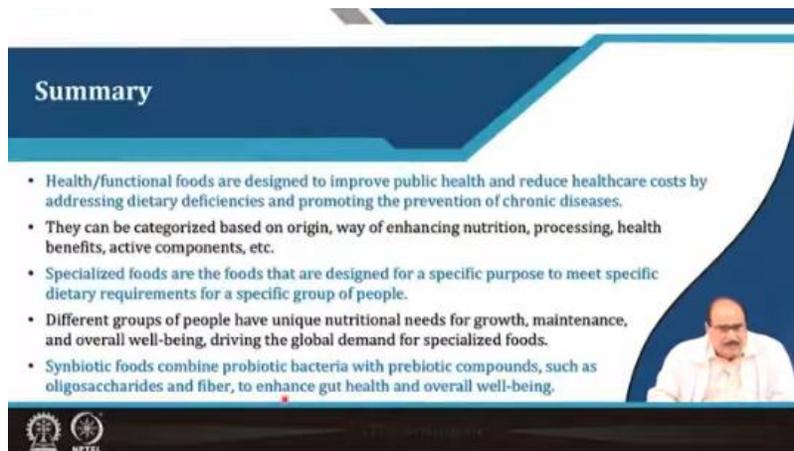
So, we got co-encapsulated probiotic GABA powder, which is the bacteria and GABA probiotic powder. This is the bacteria and GABA probiotic powder in bottle content. And this powder could be stored for 2 years with activity of more than  $10^{10}$  CFU per gram under refrigerated conditions, meaning live bacteria are present in this dry powder for over 2 years. Now, these probiotic bacteria are used in preparing a probiotic GABA-enriched bar. So, what was done? Using mixture design and formulation, we formulated, sorry, a linear programming was done.

Different ingredients were taken, bengal gram, honey, seedless dates, finger millets, groundnut and oat flakes, and the proportion of these ingredients that is on the basis of we should have that is the energy, specific energy and protein requirement were calculated and decided that is what should be the proportion of these ingredients. So, basically in that proportion told by linear programming for a specific energy content, for a specific protein content, and that was used taken in planetary mixer.

So, these ingredients in the either which were some in roasted form or in the powder form. Powder roasted in the fine mesh size powders etcetera in flour the in flour farm flour and this powder GABA and probiotic powder they were both mixed together. A

composite mix was obtained, it was molded and finally, heating in the baking ovens etcetera to get the probiotic bar, synbiotic that is it is a controlling both like inulin etcetera it is having bacteria as well as wall material usage is support the growth of the probiotics. So, you get it is a probiotic count is 7.53 after the manufacture, log CFU per gram, GABA content is 55.78 milligram per 100 grams.

So, this is a neuroprotectant and it is stored at 4 °C, it is stored alive at 4 °C. I think for 5 to 6 months easily it at the bacteria will remain alive. So, this is another product. So, there are several example one can formulate, one can design, this thing.



**Summary**

- Health/functional foods are designed to improve public health and reduce healthcare costs by addressing dietary deficiencies and promoting the prevention of chronic diseases.
- They can be categorized based on origin, way of enhancing nutrition, processing, health benefits, active components, etc.
- Specialized foods are the foods that are designed for a specific purpose to meet specific dietary requirements for a specific group of people.
- Different groups of people have unique nutritional needs for growth, maintenance, and overall well-being, driving the global demand for specialized foods.
- Synbiotic foods combine probiotic bacteria with prebiotic compounds, such as oligosaccharides and fiber, to enhance gut health and overall well-being.

The slide also features a small video inset of a man in a white shirt speaking, and logos for IIT Bombay and NPTEL at the bottom left.

So, with this, I will summarize this lecture by saying that health and functional foods are designed to improve public health and reduce healthcare costs by addressing dietary deficiencies and promoting the prevention of chronic diseases. They can be categorized based on the origin, way of enhancing nutrition, processing, health benefits, active components etcetera.

Specialized foods are designed for a specific purpose to meet dietary requirements for a particular group of people. Different groups of people have unique nutritional needs for growth, maintenance, and overall well-being, driving the global demand for specialized foods. Synbiotic foods combine probiotic bacteria with prebiotic compounds, such as oligosaccharides and fibers, to enhance gut health and overall well-being. So, one should use this knowledge, and one can, as there is a vast future for functional foods, health foods, etcetera.

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These are the references used in this lecture.



**THANK YOU !**

Thank you very much for your patience. Thank you.