Page 1 of 31 Pages in this Full pdf

MVP-007 Emerging Trends in Food Technology and Safety
Guess Paper-1

Q1. What is the basic principle of PEF food processing?

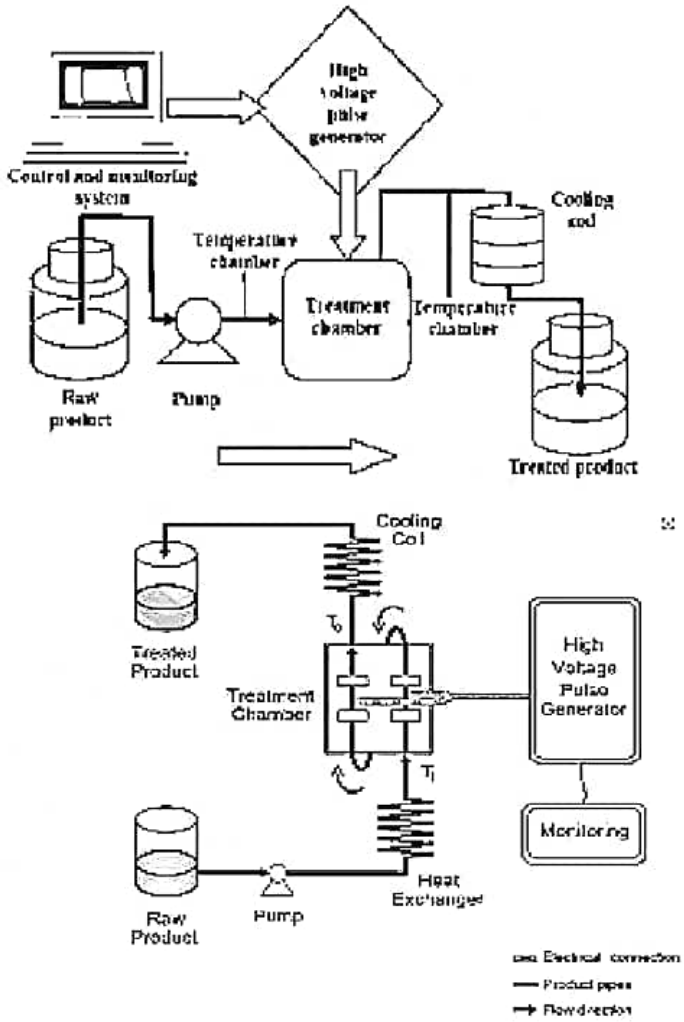
Ans. Pulsed electric field (PEF) is one of the most advanced novel processing technologies because it effectively inactivates microbes and retain qualities of food at low temperature of processing.

Principle of PEF: The basic principle of PEF food processing involves application of short pulses of high electrical field (intensity usually 10-80 kV/cm) for duration of micro to milliseconds to a food product which is placed between a set of electrodes in a processing chamber. The applied high voltage pulses create electrical field which causes electroporation in cell. Therefore, cell membranes get damaged, microbes are inactivated and shelf life of product is extended. This also causes denaturation of enzymes.

Generally the PEF is applied at room temperature and the treated product is to be packaged aseptically and stored under refrigeration. Combination of mild heat treatment (40-50°C) and PEF gives better preservative action on food.

Equipment for PEF: The basic components of a typical PEF food processing unit are processing/treatment chamber, high voltage pulse generator, fluid handling device (when PEF is used for liquid food), controlling and monitoring devices etc. (Figure 1.3).

Figure 1.3 :PEF food processing with basic components



Q2. What are the classifications of nutraceuticals?

Ans. Nutraceuticals Hippocrates (460–377 BC), the father of modern medicine, almost 2500 years back established the relation of food and its importance for the treatment of various ailments in a very classical way optimizing various benefits. Nutraceutical is composed of two words: nutrient and pharmaceutical. It is a food supplement that has a vital role in maintaining the healthy body and provides necessary supplements required for various metabolic processes to regulate body functions and thus prevents the body from diseases. Since long time, even before the development of 'Nutrition' as a distinct scientific discipline, physicians paid close attention to the role of the daily diet

Page 2 of 31 Pages in this Full pdf

in health maintenance. During the 16th, 17th and 18th centuries, many crewmen on long voyages across the Seas often died because of scurvy. The 18th century sea captains (under the direction of the British Admiralty) explored the role of various foods and food practices in maintaining the health of seamen. Some foods provided the missing vitamins B and C, whereas others reduced the antiscorbutic effects of the seamen's diet. Biomedical research during the past 20 years has revealed that diet plays an important role in the prevention and progression of many of the major chronic diseases, such as atherosclerosis and cancer.

The term 'nutraceutical' was coined in 1989 by the Foundation for Innovation in Medicine, to provide a name for this rapidly growing area of biomedical research. A nutraceutical was defined as any substance that may be considered a food or part of a food and provides medical or health benefits including the prevention and treatment of disease. Nutraceuticals may range from isolated nutrients, dietary supplements and diets to genetically engineered 'designer' foods, herbal products and processed products such as cereals, soups and beverages. Doubtlessly, many of these products possess pertinent physiological functions and valuable biological activities. The ongoing research will lead to a new generation of foods, which will certainly cause the interface between food and drug to become increasingly permeable. The present accumulated knowledge about nutraceuticals represents undoubtedly a great challenge for nutritionists, physicians, food technologists and food chemists. Public health authorities consider prevention and treatment with nutraceuticals as a powerful instrument in maintaining health and to act against nutritionally induced acute and chronic diseases, thereby promoting optimal health, longevity and quality of life. Since ancient period the mankind made medicines from the extracts of natural materials and has been used for various purposes.

In 1989 Dr. Stephen coined the term 'Nutraceuticals', which is combination of nutrition and pharmaceutical. Nutraceuticals have a come long way since a new trend in the care of companion animals emerged in the 1990s and the similar trends in the human sector as well. With the passage of the dietary supplement health and education act of 1994, the definition of nutraceuticals has been expanded to include vitamins, minerals, herbs and other botanicals, amino acids, and dietary substance for human use as a supplement diet. The term nutraceutical is not well accepted on global, regulatory systems while the dietary supplements are considered to be more prominent. Currently over 470 nutraceutical and functional food products are available with documented health benefits. The success of traditional therapies is essentially due to the art of balancing the effect of one variety of food with other so that all complimented each other.

Currently, the medical practitioners are considered as magic wand to cure disease. A recent study reports that 70% of patients typically consult a medical practitioner before or during the traditional therapy, indicates the disapproval of the natural therapy. However, the patients are much aware of the side effects, contraindications caused due to the chemical agents in short and long term therapy. Thus the interest to prevent medicine from every small disease came into trend and consequently led to new research on alternative therapies preferably with the help of nutritional approaches. This review gives highlights of some important facts regarding therapeutic use of nutraceuticals as the commercial and traditional remedies.

Classification of Nutraceuticals: The number of claimed nutraceutical substances is in the hundreds, and some of the more recognizable substances include isoflavones, tocotrienols, allyl sulphur compounds, fibre, and carotenoids. In light of a long and growing list of nutraceutical substances, organization systems are needed to allow for easier understanding and application. This is particularly true for academic instruction, as well as product formulation by food companies. Depending upon one's interest and/or background, the appropriate organizational scheme for nutraceuticals can vary. For example, cardiologists may be most interested in those nutraceutical substances that are associated with reducing the risk factors of heart disease. Specifically, their interest may lie in substances supposed to positively influence hypertension and hypercholesterolemia and to reduce free radical- or platelet-dependent thrombotic activity. Nutraceutical factors such as n-3 fatty acids, phytosterols, quercetin, and grape flavonoids would be of particular interest to them. Meanwhile, oncologists may be more interested in those substances that target anti-carcinogenic activities. These substances may be associated with augmentations of microsomal detoxification systems and antioxidant defences, or they may slow the progression of existing cancer. Thus, their interest may lie in both chemo preventive or potential adjunctive therapy.

On the other hand, the nutraceutical interest of food scientists working on the development of a functional food product will not only include physiological properties, but also stability and sensory properties, as well as issues of cost efficiency. To demonstrate this point, the anticarcinogenic triterpene-limonin is lipid-soluble and intensely bitter, somewhat limiting its commercial use as a functional food ingredient (Miller et. al., 1994). However, the glucoside derivative of limonin, which shares some of the ant carcinogenic activity of limonin, is water soluble and virtually tasteless, thereby enhancing its potential use as an ingredient. Whether it is for academic instruction, clinical trial design, functional food development, or dietary recommendations, nutraceutical factors can be organized Nutraceuticals in several ways. There are several ways of classifying Nutraceuticals. One way is according to the food source, other on the basis of mechanism of action and third on the basis of chemical nature of the functional

Page 3 of 31 Pages in this Full pdf

components. Classification on the Basis of Food Source One of the broader models of organization for nutraceuticals is based upon their potential as a food source to humans. Here nutraceuticals may be separated into plant, animal, and microbial (i.e., bacteria and yeast) groups (Refer Table 8.1).

Table 6.1 Classifcation of Nutraceuticals Grouped by Food Source

Plants	Animal	Microbial
β-Glucan	Conjugated Linoleic Acid (CLA)	Lactobacillus acidophilus
Ascorbic Acid	EicosaPentaenoic Acid (EPA)	Saccharomyces boulurdii (Yeast)
γ-Tocotrienol	DocosaHexenoic Acid (DHA)	Bifidobacterium bifidum
Quercetin	SpingolipidsB.longum	
Cellulose	Choline	B.infantis
Lutein	Lecithin	L. acidophilus (NCFB 1748)
Gallic Acid	Calcium	Streptococcus salvarius (subs. Thermophilus)
Pectin	Ubiquinone	(Coenzyme Q 10)
Lutein	Selenium	
Gallic Acid	Zinc	
Pectin		

Classification on the Basis of Mechanism of Action Another means of classifying nutraceuticals is by their mechanism of action. This system groups nutraceutical factors together, regardless of food source, based upon their proven or purported physiological properties (Refer Table 8.2).

Table 6.2 Classification on the Basis of Mechanism of Action

Anticancer	Positive Influence on Blood Lipid Profile	Antioxidant Activity	Anti-inflammatory	Osteogenetic or Bone Protective
Capsaicin	Beta-glucan	CLA	Linolenic Acid	CLA
Genestein	Tocotrienols	Ascorbic Acid	EPA	Soy Protein
Daidzein	Resveratrol	Carotene	DHA	Genestein
Tocotrienol	Tannins	Tocopherols	GLA	Daidzein
CLA	Quercetin	Tocotrienols	gamma-linolenic Acid	FOS
Lactobacillus Acidophilus	Pectin	Ellagic acid	Capsaicin	Calcium
Sphingolipids	Guar	Glutathione Gingerol	Quercetin	Casein phosphopeptides
Liminene	Saponins	Hydroxytyrosol Polyphenols	Curcumin	Inulin
Diallyl sulphide	Sitosterol	Luteolin		Fructo oligosaccharides
Ajoene , Equol	MUFA	Lycopene		
Tocopherol	Omega-3-Fatty Acids	Tannins		
Glycyrrhizin		Chlorogenic Acid		

Page 4 of 31 Pages in this Full pdf

Among the classes are included antioxidants, antibacterial, antihypertensive, antihypercholesterolemic, anti-aggregate, anti-inflammatory, anti-carcinogenic, osteoprotective, and so on. This model would be helpful to an individual who is genetically predisposed to a particular medical condition or to scientists trying to develop powerful functional foods for just such a person. This developer might consider the ingredients listed in several categories to develop a product that would reduce blood pressure, LDL cholesterol level, and inflammation.

Classification based on Chemical Nature Another method of grouping nutraceuticals is based upon their chemical nature. This approach allows nutraceuticals to be categorized under molecular/ elemental groups. This preliminary model includes several large groups, which then provide a basis for sub classification or subgroups, and so on. One way to group nutraceuticals grossly is as shown in Table .

Table Classification of Nutraceutical Factors based on Chemical Nature

Isoprenoid (Terpenoids)	Phenolic Compounds	Fatty Acids and Structural Lipids	Carbohydrate and Derivatives	Protein/ Amino Acid Based	Microbes	Minerals
Carotenoids	Coumarinns	n-3 PUFA	Ascorbic Acid	Amino Acids	Ca	Pro- biotics
Saponins	Tannins	CLA	Oligo saccharides	Allyl-S comps.	Se	Pre- biotics
Tocotrienols	Lignins	MUFA	Non-Starch PS	Capsaicinoid	K	
Tocopherols	Flavonols	Sphingo-lipids		Isothioc-yanates	Cu	
Simple Terpenes	Flavonones	Lecithin		Indoles	Zn	
	Isoflavones			Folate, Choline		
	Anthro-cyanins			Choline		

Isoprenoids and terpenoids are terms used to refer to the same class of molecules. These substances are one of the largest groups of plant secondary metabolites and are basis of many plant-derived nutraceuticals. Under this large umbrella are many popular nutraceutical families such as carotenoids, tocopherols, tocotrienols, and saponins. Most plants contain socalled essential oils, which contain a mixture of volatile monterpenes and sesquiterpenes. Limonene is found in the essential oils of citrus peels, whereas menthol is the chief monoterpene in peppermint essential oil. Two potentially nutraceutical diterpenes in coffee beans are kahweol and cafestol (Wattenberg and Lam, 1984 and Miller et. al., 1991). Both of these diterpenes contain a furan ring. As discussed by Miller and colleagues (Miller et. al., 1994), the furan ring component might be very important in yielding some of the potential antineoplastic activity of these compounds. Several triterpenes have been reported to have nutraceutical properties. These compounds include plant sterols; however, some of these structures may have been modified to contain fewer than 30 carbons. One of the most recognizable triterpene families is the limonoids. These triterpenes are found in citrus fruit and impart most of their bitter flavour. Limonin and nomilin are two triterpenoids that may have nutraceutical application, limonin more so than nomilin. Phenolic compounds are also considered secondary metabolites. The base for this very diverse family of molecules is a phenol structure. From this structure, larger and interesting molecules are formed such as anthocyanins, coumarins, phenylpropamides flavonoids, tannins, and lignin.

Phenolic compounds perform a variety of functions for plants including defending against herbivores and pathogens, absorbing light, attracting pollinators, reducing the growth of competitive plants, and promoting symbiotic relationships with nitrogen-fixing bacteria. The flavonoids are one of the largest classes of phenolic compounds in plants. The majority of naturally occurring flavonoids are actually glycosides, meaning a sugar moiety is attached. The attachment of hydroxyl groups and sugars will increase the hydrophilic properties of the flavonoid molecule, while attachment of methyl esters or modified isopentyl units will increase the lipophilic character.

The glucose derivative ascorbic acid (vitamin C) is perhaps one of the most recognizable nutraceutical substances and is a very popular supplement. Ascorbic acid functions as a nutraceutical compound, primarily as an antioxidant. Meanwhile, plants produce some oligosaccharides that appear to function as Prebiotics substances. Several plant polysaccharide families are not readily available energy sources for humans as they are resistant to secreted digestive enzymes. These polysaccharides are grouped together along with the phenolic polymer compound lignin to form one of the most recognizable nutraceutical families - fibres. By and large the role of fibres is structural for plants. For example, cellulose and hemicellulose are major structural polysaccharides found within plant cell walls. Beyond providing structural characteristics to plant tissue, another interesting role of certain fibers is in tissue repair after trauma, somewhat analogous to scar tissue in animals. The non-starch polysaccharides can be divided into

Page 5 of 31 Pages in this Full pdf

homogeneous and heterogeneous polysaccharides, as well as into soluble and insoluble substances. Another homopolysaccharide is pectin where the repeating subunits are largely methyl-galacturonic acid units. It is a jelly-like material that acts as the cellular cement in plants. Chemically related to pectin is chitin. Chitin is not a plant polysaccharide but is found within the animal kingdom, although not necessarily in humans. It is a β 1-4 homo-polymer of N-acetylglucosamine found in shells or exoskeletons of insects and crustacean. Chitin has recently surfaced as a dietary supplement for weight loss.

Several fatty acids and their derivatives that have received the interests of researchers for their functional potential. These include the omega -3 PUFA found in higher concentrations in plants, fish, and other marine Nutraceuticals animals, and Conjugated Linoleic Acid (CLA) produced by bacteria in the rumen of grazing animals such as cattle.

Amino Acid - based include intact protein (i.e., soy protein), polypeptides, amino acids, and nitrogenous and sulphur amino acid derivatives. Nowadays, a few amino acids are also being investigated for their nutraceutical potential like arginine, ornithine, taurine, and aspartic acid.

Where the other groupings of nutraceuticals involve molecules or elements, probiotics involves intact micro-organisms. This group largely includes bacteria, and its criteria are that a microbe must be resistant to: acid conditions of the stomach, bile, and digestive enzymes normally found in the human gastrointestinal tract; able to colonize the human intestine; be safe for human consumption; and, lastly, have scientifically proven efficacy. Among the bacterial species recognized as having functional food potential are Lactobacillus acidophilus, L. plantarum, L. casei, Bifidobacterium bifidum, B. infantis, and Streptococcus salvarius subspecies thermophilus. Some yeasts were noted as well, including Saccharomyces boulardii.

Several minerals have been recognized for their nutraceutical potential and thus become components for functional food recipes. Among the most obvious is calcium with relation to bone health, colon cancer, hypertension and cardiovascular disease. Potassium has also been reported to reduce hypertension and thus improve cardiovascular health. A couple of trace minerals have also been found to have nutraceutical properties. These include copper, selenium, manganese, and zinc. Their nutraceutical potential is usually discussed in relation to antioxidation. Copper, zinc, and manganese are components of Superoxide Dismutase (SOD) enzymes, whereas selenium is a component of glutathione peroxidase. Certainly more investigation is required in the area of trace elements in light of their metabolic relationships to other nutrients and the potential for toxicity.

Q3. Discuss the emerging pathogens: types, causes and implications.

Ans. Emerging pathogens are infectious agents that have recently been identified, or those that have become more prevalent or dangerous in recent years. These pathogens can arise from a variety of sources, including previously unknown or undiscovered organisms, changes in the environment or host populations, or the evolution of existing pathogens. In general, emerging pathogens are considered to pose a significant public health risk due to their potential to cause severe disease, spread rapidly, and evade existing treatments.

There are many types of emerging pathogens that have become a major concern for public health. Some of the most common types of emerging pathogens include:

- **Viruses**: Viruses are a major class of emerging pathogens, and many of the most significant outbreaks in recent years have been caused by viruses such as Ebola virus, Zika virus, and the novel coronavirus (SARS-CoV-2) that causes COVID-19. Other emerging viruses include Nipah virus, Hendra virus, and Lassa fever virus.
- **Bacteria**: Bacterial pathogens can also emerge and cause outbreaks of disease. Examples include multidrug-resistant strains of tuberculosis, carbapenem-resistant Enterobacteriaceae (CRE), and methicillin-resistant Staphylococcus aureus (MRSA).
- **Fungi**: Fungal pathogens are also emerging as a significant public health concern. For example, Candida auris is an emerging fungal pathogen that is resistant to multiple antifungal drugs and has caused outbreaks in healthcare settings.
- **Parasites**: Parasitic pathogens can also emerge and cause outbreaks of disease. Examples include Plasmodium knowlesi, a malaria parasite that infects macaques and has recently been found to infect humans in Southeast Asia, and Babesia microti, a parasite that is transmitted by ticks and causes a disease similar to malaria.
- **Prions**: Prions are infectious proteins that can cause a range of neurodegenerative diseases, including Creutzfeldt-Jakob disease (CJD) in humans and bovine spongiform encephalopathy (BSE) in cattle. While prion diseases are rare, they are considered an emerging threat due to their potential for transmission through contaminated food products.
- **Arboviruses**: Arboviruses are viruses that are transmitted by arthropod vectors such as mosquitoes, ticks, and sandflies. Examples of emerging arboviruses include chikungunya virus, dengue virus, and West Nile virus.
- **Toxins**: Certain toxins produced by bacteria or algae can also be considered emerging pathogens. For example, cyanobacteria can produce harmful toxins that can contaminate water supplies and cause illness in humans and animals.

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