Journal Of Harmonized Research (JOHR)

Journal Of Harmonized Research in Pharmacy
3(2), 2014, 48-57

ISSN 2321 – 0958

Review Article

EFFECT OF NUTRACEUTICAL ON HUMAN HEALTH: A REVIEW

Kalita Ramen*, Das Trishna

Girijananda Chowdhury Institute of Pharmaceutical Science,
Guwahati, Assam, India

Abstract:
Nutraceuticals are food product that provides health as well as medical benefits; including the prevention and treatment of disease. A few no of nutraceuticals are being used as pharmaceutical and a number of other being used by the general public as self-medication. Such products may range from dietary supplements to genetically engineered foods, herbal products and processed foods. Clinical research on nutraceutical product is going on for integrating and assessing information. Nutraceuticals are present in most of the food ingredients with varying concentration .Concentration, time and duration of supply of nutraceuticals influence human health.Manipulating the foods, the concentration of active ingredients can be increased.Diet rich in nutraceuticals along with regular exercise, stress reduction and maintenance of healthy body weight will maximise health and reduce disease risk.

Keyword: Nutraceutical, Functional food, Classification, Health benefit.

Introduction

Nutraceutical, a portmanteau of the words “nutrition” and “pharmaceutical”, is a food or food product that reportedly provides health and medical benefits, including the prevention and treatment of disease. Health Canada defines the term as "a product isolated or purified from foods that is generally sold in medicinal forms not usually associated with food. A nutraceutical is demonstrated to have a physiological benefit or provide protection against chronic disease." Such products may range from isolated nutrients, dietary supplements and specific diets to genetically engineered foods, herbal products, and processed foods such as cereals, soups, and beverages. With recent developments in cellular-level nutraceutical agents, researchers, and medical practitioners are developing templates for integrating and assessing information from clinical studies on complementary and alternative therapies into responsible medical practice The term

For Correspondence:
ramengips89ATgmail.com
Received on: April 2014
Accepted after revision: April 2014

nutraceutical was originally defined by Dr. Stephen L. DeFelice, founder and chairman of the Foundation of Innovation Medicine (FIM), Crawford, New Jersey. Since the term was coined by Dr. DeFelice, its meaning has been modified by Health Canada which defines nutraceutical as: a product isolated or purified from foods, and generally sold in medicinal forms not usually associated with food and demonstrated to have a physiological benefit or provide protection against chronic disease. Examples are beta-carotene and lycopene. Nutraceutical foods are not subject to the same testing and regulations as pharmaceutical drugs.

Market and demand:

Nearly two-thirds of the American population takes at least one type of nutraceutical health productThe use of nutraceuticals, as an attempt to accomplish desirable therapeutic outcomes with reduced side effects, as compared with other therapeutic agents has met with great monetary success. The preference for the discovery and production of nutraceuticals over pharmaceuticals is well seen in pharmaceutical and biotech companies. Some of the pharmaceutical and biotech companies, which commit major resources to the discovery of nutraceuticals include Monsanto, American Home Products, Dupont, BioCorrex,Abbott Laboratories, Warner-Lambert, Johnson & Johnson, Novartis, Metabolex, Scio-tech, Genzyme Transgenic, PPL Therapeutics, Unigen, and Interneuron The nutraceutical industry in the US is about $86 billion. This figure is slightly higher in Europe and, in Japan, represents approximately a quarter of the $6 billion total annual food sales.

Nutraceutical products were considered alternative medicine for many years. Nutraceuticals have become a more mainstream supplement to the diet, now that research has begun to show evidence that these chemicals found in food are often effective when processed effectively and marketed correctly.

Effectivness and safety:

Regulation:-

Unlike pharmaceutical drugs, within the United States, nutraceutical products are widely available and monitored with the same level of scrutiny as "dietary supplements". Within the oversight of the Federal Food & Drug Administration, unlike many other countries such as Canada, the use of broad-based definitions creates inconsistent credibility distinguishing the standards, function, and effectiveness between "nutraceuticals" and "dietary supplements". Within this loose regulatory oversight, legitimate companies producing nutraceuticals provide credible scientific research to substantiate their manufacturing standards, products, and consumer benefits and differentiate their products from "dietary supplements".Despite the international movement within the industry, professional organizations, academia, and health regulatory agencies to add specific legal and scientific criterion to the definition and standards for nutraceuticals, within the United States the term is not regulated by FDA. The FDA still uses a blanket term of "dietary supplement" for all substances without distinguishing their efficacy, manufacturing process, supporting scientific research, and increased health benefits.

In 2005, the National Academies Institute of Medicine and National Research Council created a blue-ribbon committee to create an improved framework for the Federal Food & Drug Administration to evaluate dietary supplements. Though the improved framework fails to distinguish between "nutraceuticals" and "dietary supplements". With the continued use of a broad definition and lacking greater distinction, a cost-effective and scientifically basedframework was needed to evaluate the safety of "dietary supplements" including those consumer products recognized internationally as "nutraceuticals".

Bioavailability:-

Bioavailability, which can be thought of as the "absorption rate" of a supplement product, is one of the main challenges in finding effective nutraceutical products. Among unprocessed foods, not all foods are broken down and digested as effectively. Nutraceuticals with poor absorption rates results in nutrients being

disposed from the body without providing any nutritional or medicinal benefit.

Impact of placebo effect:-

Similar to pharmaceuticals, part of the effectiveness of nutraceuticals may be attributed to the placebo effect. Consumers using nutraceuticals may inaccurately credit their use of nutraceuticals for healing illness, when the body is often able to recover on its own.

Classifications:-

The food products used as nutraceuticals contain antioxidant, prebiotics, probiotics, omega-3-fatty acids and certain dietary fibres.

1. Antioxidant:

Antioxidants or inhibitors of oxidation are the compounds, which retard or prevent the oxidation and in general prolong the life of the oxidizable matter.The reactive oxygen species(ROS) in the body,include superoxide anion, singlet oxygen, hydroxyl radical and hydrogen peroxide.The oxidative damage initiaied by them is propagated by lipid peroxidation, which may cause further damage to DNA.The body defence system against the oxidative damage consists of enzymes such as superoxide dismutase, glutathione peroxidase,catalase and the reducing agents such as glutathione, ascorbic acid and iron.

Mechanism of action of antioxidant:-

In general, reactive oxygen molecules circulating in the body, tend to react with electrons of other molecules of the body and the various enzyme systems; with the result the molecules as well as the enzyme system of the body is damaged, which may further contribute to conditions such as cancer, ischemia, aging, and rheumatoid arthritis etc.It has also been observed that the presence of free radicals cause cytotoxicity, alteration of enzymes and nucleic acids and peroxidation of the lipids, as a result there is a loss of cell membrane integrity, which initiates the aging process before time.

Naturally occurring antioxidant:-

Naturally occurring antioxidants which could be of the therapeutic use include superoxidasei dismutase(isolated or recombinant), tocopherols, ascorbic acid, adenosine transferrin, lactoferrin, glutathione and its precursors, carotenoids and other plant pigments, like defroxamine.

2. Probiotics:

These are live microorganisms thought to be beneficial to the host organism. According to the currently adopted definition by FAO/WHO, probiotics are: "Live microorganisms which when administered in adequate amounts confer a health benefit on the host". Lactic acid bacteria (LAB) and bifidobacteria are the most common types of microbes used as probiotics; but certain yeasts and bacilli may also be used. Probiotics are commonly consumed as part of fermented foods with specially added active live cultures; such as in yogurt, soy yogurt, or as dietary supplements.

side effects and risks:

live microorganisms have a long history of use as probiotics without causing illness in people. Some pr obiotics' safety has not been thoroughly studied scientifically, however. More information are is especially needed on how safe they are for young children, elderly people, and people with compromised immune systems.Probiotics' side effects, if they occur, tend to be mild and digestive (such as gas or bloating). More serious effects have been seen in some people. Probiotics might theoretically cause infections that need to be treated with antibiotics, especially in people with underlying health conditions. They could also cause unhealthy metabolic activities, too much stimulation of the immune system, or gene transfer (insertion of genetic material into a cell).Probiotic products taken by mouth as a dietary supplement are manufactured and regulated as foods, not drugs.

Health benefits of taking probiotics:

Some digestive disease specialists are recommending them for disorders that frustrate conventional medicine, such as irritable bowel syndrome. Since the mid-1990s, clinical studies have established that probiotic therapy can help treat several gastrointestinal ills, delay the development of allergies in children, and treat and prevent vaginal and urinary infections in women.The best case for probiotic therapy has been in the treatment of diarrhea. Controlled

trials have shown that Lactobacillus GG can shorten the course of infectious diarrhea in infants and children (but not adults). Although studies are limited and data are inconsistent, two large reviews, taken together, suggest that probiotics reduce antibiotic-associated diarrhea by 60%, when compared with a placebo.

Probiotic therapy may also help people with Crohn's disease and irritable bowel syndrome. Clinical trial results are mixed, but several small studies suggest that certain probiotics may help maintain remission of ulcerative colitis and prevent relapse of Crohn's disease and the recurrence of pouchitis (a complication of surgery to treat ulcerative colitis. Probiotics may also be of use in maintaining urogenital health. Like the intestinal tract, the vagina is a finely balanced ecosystem. Probiotic treatment that restores the balance of microflora may be helpful for such common female urogenital problems as bacterial vaginosis, yeast infection, and urinary tract infection.

3. Prebiotics:

These are non-digestible food ingredients that stimulate the growth and/or activity of bacteria in the digestive system in ways claimed to be beneficial to health. They were first identified and named by intermediate between foods and drugs. Depending on the jurisdiction, they typically receive an Marcel Roberfroid in 1995. As a functional food component, prebiotics, like probiotics, are conceptually intermediate level of regulatory scrutiny, in particular of the health claims made concerning them.

Typically, prebiotics are carbohydrates (such as oligosaccharides), but the definition may include non-carbohydrates. The most prevalent forms of prebiotics are nutritionally classed as soluble fiber. To some extent, many forms of dietary fiber exhibit some level of prebiotic effect.

Function:

The prebiotic definition does not emphasize a specific bacterial group. Generally, however, it is assumed that a prebiotic should increase the number and/or activity of bifidobacteria and lactic acid bacteria. The importance of the bifidobacteria and the lactic acid bacteria (LABs) is that these groups of bacteria may have several beneficial effects on the host, especially in terms of improving digestion (including enhancing mineral absorption) and the effectiveness and intrinsic strength of the immune system. A product that stimulates bifidobacteria is considered a

bifidogenic factor. Some prebiotics may thus also act as a bifidogenic factor and vice versa, but the two concepts are not identical.

Sources:

Traditional dietary sources of prebiotics include soybeans, inulin sources (such as Jerusalem artichoke, jicama, and chicory root), raw oats, unrefined wheat, unrefined barley and yacon. Some of the oligosaccharides that naturally occur in breast milk are believed to play an important role in the development of a healthy immune system in infant.

Effects:

Studies have demonstrated positive effects on calcium and other mineral absorption, immune system effectiveness, bowel pH, reduction of colorectal cancer risk, inflammatory bowel disorders (Crohn's Disease and Ulcerative Colitis, Hypertension (high blood pressure) and intestinal regularity Recent human trials have reinforced the role of prebiotics in preventing and possibly stopping early stage colon cancer. It has been argued that many of these health effects emanate from increased production of short-chain fatty acids (SCFA) by the stimulated beneficial bacteria. Thus food supplements specifically enhancing the growth of SCFA producing intestinal bacteria (such as clostridia and bacteroides species) are widely recognized to be beneficial.

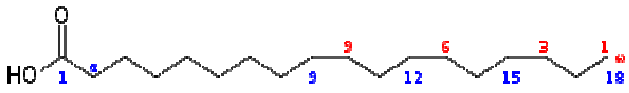
4. Omega-3 fatty acid :

Omega−3 fatty acids (popularly referred to as ω−3 fatty acids or n-3 fatty acids) are fats commonly found in marine and plant oils. They are polyunsaturated fatty acids with a double bond (C=C) starting after the third carbon atom from the end of the carbon chain. The fatty acids have two ends—the acid (COOH) end and the methyl (CH3) end. The location of the first double bond is counted from the methyl end,

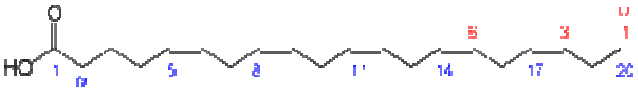
which is also known as the omega (ω) end or the n end.

N-3 fatty acids may have health benefits and are considered essential fatty acids, meaning that they cannot be synthesized by the human body but are vital for normal metabolism. Though mammals including eicosapentaenoic acid (EPA, 20 carbons and 5 double bonds), docosahexaenoic acid (DHA, 22 carbons and 6 double bonds) and α-linolenic acid (ALA, 18 carbons and 3 double bonds).Common sources of n–3 fatty acids include fish oils, algal oil, squid oil and some plant oils such as echium oil and flaxseed oil.

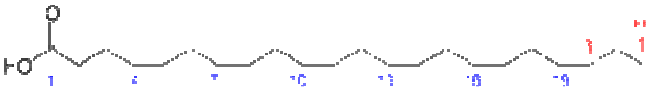
Chemistry



Chemical structure of alpha-linolenic acid (ALA), an essential n−3 fatty acid, (18:3Δ9c,12c,15c, which means a chain of 18 carbons with 3 double bonds on carbons numbered 9, 12, and 15). Although chemists count from the carbonyl carbon (blue numbering), physiologists count from the n (ω) carbon (red numbering). Note that, from the n end (diagram right), the first double bond appears as the third carbon-carbon bond (line segment), hence the name "n−3". This is explained by the fact that the n end is almost never changed during physiologic transformations in the human body, as it is more energy-stable, and other carbohydrates compounds can be synthesized from the other carbonyl end, for example in glycerides, or from double bonds in the middle of the chain.



Chemical structure of eicosapentaenoic acid (EPA).



Chemical structure of docosahexaenoic acid (DHA).

Dietary fibers:-

Dietary fiber was defined as remnants of plant cells that are resistant to digestion by human enzymes. This definition includes a component of some plant cell walls called lignin, as well as indigestible carbohydrates found in plants. However, this definition omits indigestible carbohydrates derived from animal sources (e.g., chitin) and synthetic (e.g., fructooligosaccharides) and digestible carbohydrates that are inaccessible to human digestive enzymes (e.g., resistant starch). These compounds share many of the characteristics of fiber present in plant foods.

Dietary Fiber contain,

1. Lignin: Lignin is not a carbohydrate; rather, it is a polyphenolic compound with a complex three-dimensional structure that is found in the cell walls of woody plants and seeds.
2. Cellulose: Cellulose is a glucose polymer with beta-1,4 glycosidic bonds found in all plant cell walls.
3. Beta-Glucans: Beta-glucans are glucose polymers with a mixture of beta-1,4 glycosidic bonds and beta-1,3 glycosidic bonds (see Figure). Oats and barley are particularly rich in beta-glucans.
4. Hemicelluloses: Hemicelluloses are a diverse group of polysaccharides (sugar polymers) containing six-carbon sugars (hexoses) and five-carbon sugars (pentoses). Like cellulose, hemicelluloses are found in plant cell walls.
5. Pectins: Pectins are viscous polysaccharides that are particularly abundant in fruits and berries.
6. Gums: Gums are viscous polysaccharides often found in seeds.
7. Inulin and oligofructose: Inulin is a mixture of fructose chains that vary in length and often terminate with a glucose molecule. Oligofructose is a mixture of shorter fructose chains that may terminate in glucose or fructose. Inulin and oligofructose occur naturally in plants, such as onions and Jerusalem artichokes.

8. Resistant starch: Naturally occurring resistant starch is sequestered in plant cell walls and is therefore inaccessible to human digestive enzymes. Bananas and legumes are sources of naturally occurring resistant starch. Resistant starch may also be formed by food processing or by cooling and reheating.

Classification Systems:-

Viscous and Nonviscous Fiber:-

Some fibers form very viscous solutions or gels in water. This property is linked to the ability of some fibers to slow the emptying of the stomach, delay the absorption of some nutrients in the small intestine, and lower serum cholesterol. Viscous fibers include pectins, beta-glucagon,gums (e.g., guar gum), and mucilages (e.g., psyllium). Cellulose, lignin, and some hemicelluloses are nonviscous fibers.

Fermentable and Nonfermentable Fiber:-

Some fibers are readily fermented by bacteria that normally colonize the colon. In addition to increasing the amount of bacteria in the colon, fermentation results in the formation of short-chain fatty acids (acetate, propionate, and butyrate) and gases (1). Short-chain fatty acids can be absorbed and metabolized to produce energy. Interestingly, the preferred energy source for colonocytes (epithelial cells that line the colon) is butyrate. Pectins, beta-glucans, guar gum, inulin, and oligofructose are readily fermented, while cellulose and lignin are resistant to fermentation in the colon. Foods that are rich in fermentable fibers include oats and barley, as well as fruits and vegetables.

Soluble and Insoluble Fiber:-

"Soluble fiber" originated as an analytical term . Soluble fibers are dispersible in water, while insoluble fibers are not. Originally, the solubility of fiber was thought to predict its physiological effects. However, the terms “soluble” and “insoluble” fiber are still used by many nutrition and health care professionals, as well as the U.S. Food and Drug Administration (FDA) for nutrition labeling. Beta-glucans, gums, mucilages (e.g., psyllium), pectins, and some hemicelluloses are soluble fibers, while cellulose, lignin, some pectins, and some hemicelluloses are insoluble fibers. Oat products and legumes (dry beans, peas, and lentils) are rich sources of soluble fiber.

Biological Activities:-

1.Lowering Serum Cholesterol.

2.Lowering Postprandial Glycemia (Blood Sugar).

3.Softening Stool.

4.Used in the treatement of various diseases like

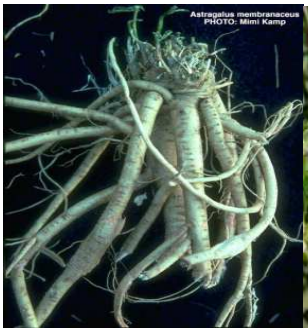
a. Cardiovascular Diseases such as coronary heart diseases and myocardial infarction.

b.Type 2 Diabetes Mellitus.

c.Colorectal Cancer.

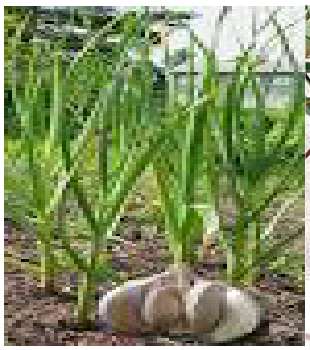
Some example of herbal plants used as nutraceuticals :

CHAMOMILE DEVIL’S CLAW EVENING PRIMROSE BALM LEMON





ASTRAGALUS ACEROLA ALFALFA ACACIA




GARLIC GINGER SAFFRON EPHEDRA

Some example of herbal plants used as nutraceuticals with their uses:

1.	ACEROLA	Malpighia glabra (Malpighiaceae).	VitaminA, thiamine, riboflavin and niacin.	1. Diarrhoea 2. Liver disorder.
2.	ALETRIS	Aletris farinose (Liliaceae)	Volatile oil, saponin glycoside.	1. Bitter digestive tonic. 2. Diuretic.
3.	ALFALFA	Medicago sativa Linn (Leguminosae).	Medicagenic acid, hederagenin, lysine, niacin, biotin.	1. General tonic. 2. Increase vitality and weight in humans.
4.	APRICOT PITS	Prunus armeniaca (Rosaceae).	Amygdalin, laetrile(3%).	Carminative properties.
5.	ANISEED	Pimpineiia anisum (Apiaceae)	Lipids, flavonoids, (2-3%)essential oil.	1. Galactogogue. 2. Spice in health food products.
6.	CAJEPUT OIL	Melaleuca leucadendra	Cineole, terpinen.	1. Flavor component. 2. Burns.
7.	ACACIA	Acacia Senegal (Leguminosae).	Arabin.	1. Hypocholesterolemic agent. 2. Suspending agent.
8.	CAPSICUM	Capsicum frutescens (Solanaceae).	Capsanthins, capsorubin, vitamin A and C.	1. Antioxidant. 2. Laxative.
9.	CORN OIL	Zea mays Linn (Gramineae).	Stearic acid, oleic acid, linolenic acid, behenic acid.	1. Dietary supplement. 2. Natural antioxidant.

10.	CARAWAY	Carium carvi (Umbelliferae).	Carvone, limonene, pinene, thujone.	1. Domestic spice. 2. Carminative.
11.	CORIANDER	Coriandrum sativum (Apiaceae).	Linalool.	1. Antispasmodic. 2. Antioxidant.
12.	DEVIL'S CLAW	Harpagophytum procumbens(Pedaliaceae).	Harpagoside, phytosterols, triterpenes.	1. Dietary supplement. 2. Natural antioxidant.
13.	ECHINACEA	Echinacea purpurea (Compositae).	Essential oil and flavonoides.	1. Wound healing property. 2. Rheumatoid arthritis.
14.	FENUGREEK	Trigonella foenum-graecum (Leguminosae).	(1-2%)sapogenin, trigonellin, alkanes, lactones.	1. Emollient. 2. Diabetes.
15.	FENNEL	Foeniculum vulgare (Umbelliferae).	Fenchone, limonene, trans anethole, estragole.	1. Health food. 2. Flavouring agent.
16.	FEVERFEW	Tanacetum parthenium (Asteraceae).	Sesquiterpene and lactones.	1. Asthma. 2. Vermifuge activity.
17.	GANODERMA	Ganoderma lucidum (Polyporaceae).	Ergosterols, protease, amino acid, 24-methylcholesta.	1. Improve energy. 2. General tonic.
18.	GARLIC	Allium sativum (Liliaceae).	Allin, s-methyl-L-cysteine sulfoxide.	1. Food supplement. 2. Antibacterial activity.
19.	GENTIAN	Gentian alutea (Gentianaceae).	Secoiridoids, gentiopicroside, amarogentin.	1. Stimulate the appetite. 2. Gastrointestinal pain.
20.	GINGER	Zingiber officinalis (Zingiberaceae).	Zingiberene, bisabolene.	1. Domestic spice. 2. General tonic.
21.	GINKGO	Ginkgo biloba (Ginkgoaceae).	Terpenoids and flavonoids.	1. Senile cerebral insufficiency. 2. Vertigo.
22.	LIQUORISE	Glycyrrhiza glabra (Fabaceae).	Dextrose, fructose, sucrose.	1. Flavouring agent. 2. Impaired digestion.
23.	HOPS	Humulus lupulus (Moraceae).	Rutin, quercetin, astragalin, chalcones.	1. Appetite stimulant. 2. Flavouring agent.
24.	LEMON OIL	Citrus limon Linn (Rutaceae).	Limonene, nonanol. Octanol, (13%)citral.	1. Flavor for food products. 2. Cosmetics.
25.	NUTMEG	Myristica fragrans (Myristicacae).	Volatile oil, proteins and starch.	1. Flavour. 2. Carminative.

26.	ONION	Allium cepa (Liliaceae).	Flavonoids and sulphur containing compounds.	1. Food supplement. 2. Diuretic.
27.	PARSLEY	Petroselinum crispum (Umbelliferae).	Myristin, limonene, flavones gltcosides.	1. Antioxidant. 2. Tea ingredients.
28.	SASSAFRAS	Sassafras albidum (Lauraceae).	Sassafras oil, (80%)saffrole, lignans.	1. Spring tonic. 2. Blood thinner.
29.	SUNFLOWER OIL	Helianthus annus (Asteraceae).	Palmitic, stearic and linoleic acid.	1. Dietary supplement. 2. Cosmetics.
30.	TAMARIND	Tamarindus indica (Leguminosae).	Pectin, tartaric acid, citric acid.	1. Laxative. 2. Dysentery.
31.	TURMERIC	Curcuma longa Linn (Zingiberaceae).	Turmerone, zingiberene, borneol.	1. Stimulate appetite. 2. Constipation.
32.	SAFFRON	Crocus sativus (Iridaceae).	Crocin, picrocrocin.	1. Antioxidant. 2. Dietary supplement.
33.	MUSTARD OIL	Brassica nigra (Cruciferae).	Volatile oil, fixed oil, proteins and mucilage.	1. Food supplement. 2. Anticarcinogenic properties.
34.	HONEY	Apis melifera (Apidae).	Dextrose and fructose.	1. Nutrient and Sweetner. 2. Improved digestion.

Conclucion:-

It is the wish of all people to live healthy. It is natural that people's focus is shifting from medica treatment for sickness to a positive approach for prevention of diseases to stay healthy. In order to prevent diseases and be healthy, new food products, which have been proven by the human trials tobe effective to prevent diseases, should gradually penetrate into the society. This will improve QOL (quality of life) of all people.

Nutraceuticals is a scientific area generatedfrom Japan to the world. It can be said that Japan created brand-new conception of food.In order to develop this movement, not only for the improvement of scientific research levels, but also for the improvement of the quality of life by utilization, it is required to note the following three actions: (1) establishment of scientific assessment standardfor prevention of diseases, (2) establishment of assessment system for disease prevention by human trials and (3) establishmentof seamless system to transfer stage from basic research to industrialization.

References:-

1. Gibson GR, Roberfroid MB. Dietary modulation of the human colonic microbiota: introducing the concept of prebiotics. J Nutr. 1995 Jun;125(6):1401-12. PMID.

2. Roberfroid MB; Prebiotics: The Concept Revisited. J Nutr. 2007; 137: 830S.

3. Marcel Roberfroid; Prebiotics: The Concept Revisited. J Nutr. 2007; 137: 830S.

4. Brigitta Kleessen*, Ludger Hartmann and Michael Blaut; Oligofructose and long-chain inulin: influence on the gut microbial ecology of rats associated with a human faecal flora British Journal of Nutrition (2001), 86, 291–300.

5. Zeisel S. H., Regulation of "Nutraceuticals.",Science, 285:185-186 (199)[7] Whitman M., Understanding the perceivedneed for complementary and alternative nutraceuticals: lifestyle issues. Clin J Oncol Nurs., 5:190-194 (2001).

6. Heyland D. K. In search of the magic nutraceuticals: problems with current approaches. J Nutr.131(9):2591S-2595S(2001).

7. Elizabeth A. C., Over the -counter products:nonprescription medications,

nutraceuticals,and herbal agents. Clin Obstet Gynecol.,45(1):89-98 (2002).
8. Pharmacognosy and Phytochemistry - Part II, 1st edition by Vinod. D. Rangari.
9. Pharmacognosy by C.K Kokate.
10. Nutraceutical - Definition and Introduction AAPS Pharmsci 2003; 5 (3) Article 25.
11. Critical Reviews in Food Science and Nutrition, 45: 645-656 (2005).
12. Food and Nutrition, Vol. I & II by S. Swaminathan.
13. www.healthandyoga.com http//en. Wikipedia.org /wiki/ nutraceutical