CHAPTER I
GENERAL INTRODUCTION

1.1. Nutraceutical – An Overview

Nutrition is a basic need as various risk factors related to health result due to an imbalanced nutrition. These nutritional imbalance incidences are widely prevalent in India leading to adverse conditions. Certain sector of the population consumes diet which does not provide sufficient calories and balanced nutrition. In India, nearly 20% of the total population and 44% of young children (below 5 years of age) are exposed to under nourished conditions and are also underweight. On the other hand, there is a huge population that is nourished in calorie intake but not in terms of nutrient intake. This segment would typically include middle to upper class population with sufficient purchasing capacity to buy nutrients but probably less aware about their nutrient requirements, again leading to imbalanced nutritional uptake (Pandey et al., 2013).

Since the industrial age initiation, lifestyle of human being has dramatically changed. Increased work load, fast living and various psychological pressures have forced people to various eating cultures such as instant and tasty meals, but decreased the quantity and quality of nutrients. At the same time, industrialization has caused numerous air and water pollutions, and soil and food contamination because of extensive use of various chemicals, heavy metals, electromagnetic waves, and other potentially harmful man-made items existing in industries. These problems have led to increased incidences of diabetes, obesity, various cancers and vascular diseases, physiological problems, as well as other degenerative diseases. The increased demand for health care has dramatically raised the cost of medical care. Now, more and more people realize that a healthy body is more important than money or work. Therefore, people are trying to achieve a better quality life by eating more vegetables, fruits, plant foods, dietary supplements or Nutraceuticals. About 2000 years ago, Hippocrates correctly emphasized this concept as “Let food be your medicine and medicine be your food”.

The term ‘Nutraceutical’ was coined in 1989 by Stephen Defelice, founder and chairman of foundation for innovation in medicine, an American organization which encourages medical health (De Felice L...
Stephen, 1995; Jack, 1995). According to him “Nutraceutical is any substance that is a food or a part of food and provides medical or health benefits, including the prevention and treatment of disease”. Such products may range from isolated nutrients, dietary supplements and specific diets to genetically engineered designer foods and herbal products (Rishi, 2006).

The concept of Nutraceutical started from the survey conducted in U.K., Germany and France and it is concluded that diet is rated highly by consumer then exercise or hereditary factors in achieving a good health (Brower, 1998; Mannion, 1998). In the U.S. “Nutraceutical" is commonly used, but no regulatory definition existed. Its meaning was modified by health ministry of Canada which defines Nutraceutical as “a product isolated or purified from the food, generally sold in medicinal form not associated with food and demonstrated to have a physiological benefit. It also provides benefit against chronic disease” (Bull Esther, 2000).

In Britain, the Ministry of Agriculture, Fisheries and Food has developed a definition of a functional food as a food that has a component incorporated into it to give it a specific medical or physiological benefit, other than purely nutritional benefit (Manisha Pandey et al., 2010).

1.2. Groups of Nutraceuticals (Sridivya et al., 2010)

1.2.1. Herbals - Herbs or botanical products as concentrates and extracts

1.2.2. Sports nutrition and dietary supplements

Reagents derived from other sources eg. pyruvate, chondroitin sulphate, steroid hormones, precursors serving specific functions

1.2.3. Functional food & beverages

The dietary supplements segment in the US was growing at roughly 3.1 percent while the functional food and beverages segment was growing at the rate of 5.6 percent. In Australia, vitamins and dietary supplements is growing at the rate of 7% which is valued at USD $ 13.43
Fig. 1: Groups of Nutraceuticals

**NUTRACEUTICALS**

- **Dietary supplements**
  - Vitamines and Mineral Supplements
    - Minerals
    - Vitamins
  - Herbal Supplements
    - Algal extracts
    - Plant extract & Phytochemicals
    - Ayurvedic Formulations
  - Protein Supplements
    - Protein Power and Lifestyle Products
    - Sports Nutrition

**Functional food & Beverages**

**Functional Foods**
- Omega Fatty Acid Fortified Foods
- Probiotic Fortified Foods
- Branded Iodinised Salts
- Branded Wheat Flours

**Functional Beverages**
- Energy Drinks
- Sports Drinks
- Fortified Juices
1.3. **International and National Status** ([www.bccresearch.com](http://www.bccresearch.com); Andlauer, 2002; Gupta *et al*., 2013).

The global Nutraceutical market was valued at $160.6 billion in 2013 and increased to $171.8 billion in 2014.

1.3.1. **China** is expected to be the largest consumer of Nutraceutical ingredients by 2020

1.3.2. **Japan** is currently the second largest individual consumer of Nutraceuticals (behind the U.S)

1.3.3. **India**

Unlike its regional neighbours, India’s market share is not much from the dietary supplements. At present, the Nutraceutical Industry in India is about 2.2 billion and is mainly focused in the Southern region and Eastern region

**Others**

- In 2020, the US Nutraceutical market will be $70.4 billion making it the largest in the world
- European Nutraceutical Industry is valued at US $45 billion in 2020

1.4. **Need for Nutraceuticals** (Umesh *et al*., 2012)

- Adequate nutrition is not available in the routine food
- Present day living environment is highly toxic due to pollution and pesticides because of these body loses its proper functioning power
- There are side effects arising due to administration of synthetic drugs
- A good quality dietary supplementation absorbed and utilized by the body can truly strengthen our body and add to vitality hence we are in need of nutraceuticals

1.5. **Nutraceuticals - Merits** (Prasad Palthur *et al*., 2010)

- Increases the health value of the diet
- Helps in promoting longevity
- Provides psychological benefits
- Less likely to produce unpleasant side effects
- Nutrient rich foods are beneficial especially for elder people
- Possess prolonged half life
- Can be easily absorbed in the intestine
- Easily procurable without prescription
- Many people believe that Nutraceutical approach is more natural than using medical practitioner’s prescribed drug
- Some people turn towards Nutraceuticals when they feel that standard treatments provided for their specific illnesses are not satisfactory

The Nutraceutical products are recognized as to produce health benefits such as reducing the risk of cancer and heart disease and also in hypertension, high cholesterol, excess weight, osteoporosis, diabetes, arthritis, macular degeneration (leading to irreversible blindness), cataract, menopausal symptoms, insomnia, diminished memory and concentration, digestive upsets and constipation. Few products prevent thinning of hair, lack of confidence, poor complexion, varicose veins, alcoholism, depression and lethargy (Fereidoon Shahidi, 2005). Since the early 1990s, in developing countries it is observed that there has been a considerable shift in consumers perspective towards Nutraceuticals and functional foods.

Currently, consumers are much more conscious and are aware about health and many share the perception that the onset of many chronic diseases can be prevented with the proper intake of nutritious diet. Food supplements are not only being consumed for just meeting the recommended dietary allowance but also as a mechanism for performance enhancement and disease prevention. Increased access to information through education and an enquiring media has resulted in a rapidly emerging self-care movement among consumers. As well, our understanding of the mode of action, health promoting effects and value added properties of food and non-food products are increasing rapidly. When coupled with increased economic prosperity, health awareness is driving more consumers to take a more protective role in managing their health through Nutraceutical people are less willing to simply wait and implement health care advice provided by the medical community in response to health problems (Caetano et al., 2010).
Powerful market forces are fueling the interest in Nutraceuticals (Radhika, 2011)

- Rapid advances are made towards the enrichment of scientific knowledge in supporting the vital role of diet in health and disease prevention
- Technical advancement in the food industry has led to the development of health promoting foods

1.6. Synthetic Nutraceuticals (Kumar Satinder et al., 2012; Sarin Rajat et al., 2012; Dureja et al., 2003)

**Table 1: Synthetic Nutraceuticals- Existing synthetic dietary supplements**

<table>
<thead>
<tr>
<th>Product</th>
<th>Category</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coral calcium</td>
<td>Calcium supplement</td>
<td>Nature’s answer, Hauppauge, NY, USA</td>
</tr>
<tr>
<td>Weight smart</td>
<td>Nutritional supplement</td>
<td>Bayer corporation, Morristown,NL, USA</td>
</tr>
<tr>
<td>Omega women</td>
<td>Immune supplement</td>
<td>Wassen, Surrey, U.K.</td>
</tr>
<tr>
<td>Appetite Intercept</td>
<td>Appetite suppressant</td>
<td>Natrol, Chatsworth, CA, USA</td>
</tr>
<tr>
<td>Chaser</td>
<td>Hangover supplement</td>
<td>Living essentials, Walled lake,MI, USA</td>
</tr>
<tr>
<td>Rox</td>
<td>Energy drink</td>
<td>Rox America, Spartanburg, SA, USA</td>
</tr>
<tr>
<td>Mushroom optimizer</td>
<td>Immune supplement</td>
<td>Jarrow formulas, Los Angeles, CA, USA</td>
</tr>
<tr>
<td>Biovinca</td>
<td>Neurotonic</td>
<td>Cyvex nutrition, Irvine, CA, USA</td>
</tr>
<tr>
<td>Proplus</td>
<td>Nutritional supplement</td>
<td>Campbell soup company, Camden, NJ, USA</td>
</tr>
<tr>
<td>Snapple-a-day</td>
<td>Meal replacement beverage</td>
<td>Snapple beverage group, White Plains, NY, USA</td>
</tr>
<tr>
<td>Wellife</td>
<td>Amino acids supplement</td>
<td>Daesang America Inc., Hackensach, NJ, USA</td>
</tr>
<tr>
<td>P Ner plus</td>
<td>Neuropathic pain supplement</td>
<td>NeuroHelp, San Antonio, Texas, USA</td>
</tr>
<tr>
<td>Olivenol</td>
<td>Dietary supplement</td>
<td>Cre Agri, Hayward, CA, USA</td>
</tr>
<tr>
<td>Threptin diskettes</td>
<td>Protein supplement</td>
<td>Raptakos, Brett &amp; Co. Ltd., Mumbai, India</td>
</tr>
<tr>
<td>GRD</td>
<td>Nutritional supplement</td>
<td>Zydus Cadila Ltd., Ahmedabad, India</td>
</tr>
<tr>
<td>Proteinex</td>
<td>Protein supplement</td>
<td>Pfizer Ltd., Mumbai, India</td>
</tr>
<tr>
<td>Calcitriol D-3</td>
<td>Calcium supplement</td>
<td>Cadilla healthcare limited, Ahmedabad, India</td>
</tr>
</tbody>
</table>
1.7. Demerits of synthetic Nutraceuticals - FDA alerts as per adverse effects caused by synthetic Nutraceuticals (Mechanick \textit{et al.}, 2001)

FDA has given alerts about the adverse effects caused by synthetic Nutraceuticals

\begin{itemize}
  \item $\gamma$-hydroxy butyric acid, $\gamma$-butyro lactone, $\gamma$-1,4-butane diolis lead to coma and death
  \item 5-hydroxy-L-tryptophan causes sedation
  \item Sleeping buddha, an unlabeled prescription drug contains estazolam that damages the fetus
  \item With extensive anecdotal data on exciting health results, herbal Nutraceuticals promise significant contributions to disease prevention
\end{itemize}

1.8. Need for herbal Nutraceuticals (Shagufa Khan, 2005; Srividya \textit{et al.}, 2010)

There has been observed an increased global interest and acceptance of traditional medicinal products. Efforts to monitor and regulate traditional herbal medicines are underway. Ayurveda - the traditional Indian system of medicine remains the most ancient yet a living tradition. In India, about 70 percent of rural population depends on the traditional systems of medicine and Nutraceuticals for their primary healthcare needs,

\begin{itemize}
  \item Research should focus towards the development of safe, pure and potent Nutraceutical products
  \item Usage of proper and authentic raw materials to be encouraged
  \item To develop scientific methods for ensuring and checking the quality, consistency and dosage of ingredients (Soni Kriti and Naved Tanveerb, 2011)
\end{itemize}

Increased cost and serious side effects of existing synthetic Nutraceuticals and increased number of incidences with chronic diseases lead the society to search for alternative source to meet their Nutraceutical requirements which is safe and can promote human health without any side effects. This prompted us to focus our search towards the development of a safe and efficacious herbal Nutraceuticals from the common plant sources available in Southern peninsula.
1.9. Nutraceuticals in Ayurveda (Yogita Rani and Sharma, 2005)

With this view, Ayurvedic literature survey was carried out to select traditional Ayurvedic herbs that could be of Nutraceutical value. This might be because of the richness of the Nutraceutical products mentioned in the classical text of traditional system of medicine. It is estimated that in India more than 7800 manufacturing units are involved in the production of natural health products and traditional plant based formulations. Recently concept of Nutraceutical development from traditional plant sources is gaining momentum. More than 1500 herbals are sold as dietary supplements or ethnic traditional medicines (Kamboj, 2000). Numerous Nutraceutical combinations have entered the International market due to the scientific exploration carried on ethno pharmacological claims existing in different ethnic practices.

1.10. Existing Ayurvedic and herbal Nutraceuticals
(http://www.andrews.edu/NUFS/functionalfoods.html)

Table 2: Existing Ayurvedic and herbal Nutraceuticals

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Herbal Nutraceutical</th>
<th>Ingredients</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shatavari</td>
<td>Shatavari root powder and leaves of <em>Asparagus racemosus</em></td>
<td>Used internally for infertility, loss of libido, threatened miscarriage, menopausal problems. It nourishes and cleanses the blood and the female reproductive organs. It is a good food during menopause or for those who have had hysterectomies, as it provides many female hormones. It nourishes the ovum and increases fertility. This herb is known to increase <em>Sattva</em>, or positivity and healing power. It also enhances the feelings of spiritual love, and increases ojas. The male reproductive system is also benefitted by Shatavari. It may be used in cases of sexual debility, impotence, spermatorrhea, and inflammation of sexual organs. Useful in hyperacidity, stomach ulcers, dysentery, and bronchial infections.</td>
</tr>
</tbody>
</table>
| 2      | Guggulu capsules     | Each capsule contains 250mg extract of *Shuddha* | • Hyperlipidemia  
• Arthritis  
• Atherosclerosis |
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Guggulu. Shuddha Guggulu</td>
<td>Contains resin, volatile oils and gum. The extract has ketonic steroid compounds known as guggulsterones</td>
<td>• Weight management</td>
</tr>
</tbody>
</table>
| 3      | Shallaki tablet | Each uncoated tablet contains extract of *Boswellia serrata* | • Helpful in body pains  
  • Useful in arthritic condition  
  • Reduces back pain  
  • Helps in healing of fracture very fast  
  • Relieve muscular spasms and stiffness |
| 4      | Brahmi capsule | *Bacopa monnieri* contains the alkaloids brahmine, herpestine along with saponins, monnierin and hersaponin, bacosides A and B | **Adolescents and adults:**  
  • Memory disturbance  
  • Mental fatigue  
  • As a supplement to improve mental ability  

**Elderly:**  
• Dementia  
• Improvement of memory |
<p>| 5      | Amla capsules | A pure herb extract of *Emblica officinalis./Amla or Amalaki contains the highest natural source of Vitamin C and cytokine like substances identified as zeatin, z. riboside, z. nucleotide. Amla also has naturally occurring bioflavonoids. It is believed that what gold is to the minerals, amla is to the herbs and is the most widely used herb in the Ayurveda system of medicine. | Rich in anti-oxidant content, rejuvenative, promotes longevity, skin health, lung health, eye health and overall well being. |</p>
<table>
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</tr>
</thead>
</table>
| 6      | Tulsi capsule        | Tulasi (Holy basil / *Ocimum sanctum*) contains ursolic acid in leaves | Used in following conditions,  
- Upper respiratory tract disorders  
- In productive & dry cough, Recurrent respiratory infections  
- Supportive therapy for chronic lung diseases.  
- In chronic obstructive pulmonary disease  
- In asthma and bronchitis |
| 7      | Diabecon DS         | Gymnema (*Meshashringi*), Indian Kino tree (*Pitasara*), Shilajeet | In NIDDM used as a monotherapy or as an adjuvant to other oral anti-diabetic drugs  
- For NIDDM with signs and symptoms of hyperlipidemia  
- For NIDDM with early retinopathy  
- For NIDDM with microalbuminuria  
- As an adjuvant in insulin-dependent diabetes mellitus (IDDM/type I) |
| 8      | Cystone              | Small Caltrops (*Gokshura*), Pasanabheda (*Saxifraga ligulata*), Shilapushpa (*Didymocarpus pedicellata*) | In the prevention and treatment of adult and pediatric urolithiasis (kidney stone formation), including calcium oxalate stones, calcium and phosphate stones and uric acid and urate bladder stones  
- Useful in crystalluria (presence of crystals in urine)  
- In the prevention of post lithotripsy (removal of kidney stones with shockwaves) and recurrence of stones  
- Useful as an adjuvant in chronic UTI, nonspecific urethritis (irritation or swelling of the urethra) including dysuria (painful urination or the cases of urine with blood), burning micturition (urination) and hyperuricemia (gout) |
| 9      | Abana                | Arjuna, Guggul | Useful in dyslipidemia (high cholesterol and triglycerides)  
- Useful in mild to moderate hypertension  
- Useful in cardiovascular and cerebrovascular conditions requiring the inhibition of platelet aggregation  
- Used as an adjuvant in the therapy of angina, and in patients with cardiac risk factors |
### 1.11. List of some common chemical compounds used as Nutraceuticals isolated from plants (Neha Pandey, 2011)

**Table 3: Chemical compounds isolated from plants used as Nutraceuticals**

<table>
<thead>
<tr>
<th>Plant sources</th>
<th>Chemical / Nutraceutical Compounds</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Allium sativum</em></td>
<td>Allicin</td>
<td>A powerful anti-fungal and anti-bacterial agent. It has been also proven to be an anti-oxidant and has been used to treat arteriosclerosis and serum cholesterol.</td>
</tr>
<tr>
<td>Green leafy vegetables and germinated grains</td>
<td>Betaine (Trimethyl glycine)</td>
<td>Reduces toxic buildup of homocysteine.</td>
</tr>
<tr>
<td><em>Ananas sp</em></td>
<td>Bromelain</td>
<td>Pineapple protease enzyme present in this fruit is used to prevent heart disease, reduces the effects of aging, improves the immune system and also reduces arthritis and inflammation.</td>
</tr>
<tr>
<td><em>Cinnamomum camphora</em></td>
<td>Camphor</td>
<td>As an inhalant to treat cold and flu.</td>
</tr>
<tr>
<td><em>Capsicum annum</em></td>
<td>Capsaicin or trans 8 methyl N vanillyl 5 nonenamide</td>
<td>Used topically as a pain reliever and as a digestive aid. It is also used as an anti-oxidant. It can pose a risk of allergic reactions and can cause severe damage to the eyes or skin if used in higher doses.</td>
</tr>
<tr>
<td><em>Asparagus recemosa</em></td>
<td>Carnitine or L Carnitine</td>
<td>Responsible for the transportation of long chain fatty acid groups into the mitochondria.</td>
</tr>
<tr>
<td><em>Vitis vinifera L.</em></td>
<td>Proanthocyanins</td>
<td>Helps in urinary tract infections by inhibiting adhesion of microorganisms like <em>E. coli</em> to the urinary tract wall.</td>
</tr>
</tbody>
</table>
Traditional crops could also be used as Nutraceuticals with vertical integration into Indian agriculture and manufacturing, which will impart rural economic development. There is however following barriers existing for introducing Nutraceutical crops:

♣ Common belief is that only imported herbals / botanicals are effective
♣ Little data only available about cultivation and adaptability of popular herbals / botanicals
♣ Wide range of manufacturing processes is available. No attention is paid for product quality extraction, effective "shelf-life", storage, ingredient standards or contamination
♣ Federal regulations are still pending which could further restrict the supply of natural products for developing dietary supplements

Bottle Neck

♣ Supply of "certified" products is limited and demand exceeds supply
♣ Most raw materials are imported and lack government / industry control on product quality and contamination

1.12. Existing Nutraceutical Industries (Rahul Dev et al., 2011)

Nutraceutical market is becoming more competitive with the entry of pharmaceutical and major food companies into the Nutraceutical arena. Many food companies have established their Nutraceutical divisions with a view to develop a diverse range of food products. In recent years a noticeable entry of major food and pharmaceutical companies were observed such as Amway, Twin Labs, General Nutrition Centers and Solgar Inc., into the Nutraceutical Industry. They have pioneered in the marketing of Nutraceuticals in the U.S. Major pharmaceutical company has also entered the Nutraceutical business either by acquiring existing smaller companies or starting their own Nutraceuticals divisions. These include

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<th>Plant sources</th>
<th>Chemical / Nutraceutical Compounds</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olea europaea</td>
<td>Olive oil</td>
<td>High in monounsaturated fat and is healthy oil in maintaining good cholesterol levels.</td>
</tr>
</tbody>
</table>
pharma companies such as Johnson & Johnson, American Home Products and Procter & Gamble.

In India almost all major pharmaceutical companies have either entered or engaged in the process of getting into this line of Nutraceutical business with standardized Ayurveda products or herbal / dietary supplements. Some major companies marketing Nutraceuticals in India are Glaxo Smith Kline consumer healthcare, Dabur India, Cadila Health care, EID Parry’s, Zandu Pharmaceuticals, Himalaya herbal Healthcare, Amway, Sami labs, Elder pharmaceuticals and Ranbaxy (FICCI-Ernst, 2009).

Hence there is a wide scope for Nutraceuticals and India should enter this market and should contribute towards economic development of the nation. As compared to synthetic Nutraceuticals, herbal Nutraceutical are safe and can promote human health without any side effects. Increasing awareness about fitness and health spurred in media coverage prompted the society to lead healthier lifestyles through exercise and eating healthy foods. The expanding Nutraceutical market indicates that end users are seeking minimally processed food with extra nutritional benefits. This development, in turn, is propelling expansion of the Nutraceutical markets globally. The emerging Nutraceuticals Industry is destined to occupy the landscape in the new millennium. Its tremendous growth has implications in food, pharmaceutical, healthcare and agricultural Industries. Global trends seen at present towards healthy products cannot be reversed. Health improvements mediated by “Nutraceuticals” or “Dietary supplement” have triggered an increased global interest. Supplements are products such as vitamins, minerals, amino acids derived from natural sources which are included in the diet, but without any therapeutic benefit. However Nutraceuticals possess on additional advantage in the prevention or management of diseases or disorders and used as a conventional food. A number of biological mechanisms and pathophysiological processes are influenced by Nutraceuticals and can contribute to the human health as well in improving national economy. Hence in the present study an attempt is made to develop a quality herbal Nutraceutical from the common plant sources available in and around Thanjavur district.