CHAPTER II
REVIEW OF LITERATURE

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The term “Review of Literature” consists of two words. Review means to organize the existing knowledge of specific area of research to involve any adaptable knowledge to ensure that the study would be an addition to this field; and Literature is used in research in reference to the knowledge of the particular area of investigation of any discipline. Study of literature also implies locating, reading and evaluating research reports as well as casual observations and opinions that have been expressed in relation to the research projects. In fact, research endeavors are made based upon past knowledge, to explore newer frontiers. Thus, this step helps to eliminate the duplication of what has been done and provides useful hypothesis and helpful suggestions for undertaking investigations of significance. In essence, review of literature becomes instrumental in charting out meaningful prospective endeavors.

A comprehensive review of literature is important for any research work. Importance of relevant review cannot be overemphasized with a view that it provides sound framework for research. It involves the edifice of knowledge to show that this study could be an addition to this field.

The present study deals with the analysis of chemical composition of raw and processed Phaseolus vulgaris (Kidney beans) of three varieties and product development thereof. For this, several study reports were collected on the nutrients, antioxidants and antinutrients of the three varieties of kidney beans along with effects of processing technique and product developed by using them, to have the following systematic version.

2.1 KIDNEY BEANS: THETHREE DIFFERENT TYPES

Along with early grains, legumes were among the first crop cultivated and date back to the Bronze Age. Food legumes utilized as dry seeds often referred to as pulse or grain legumes. Although there are more than 14,000 known legume specimens, only 22 are grown and extensively promoted for human consumption. Among different legumes, dry beans are also the member of leguminous family that is mostly consumed as whole beans by human beings throughout the world (Broughton et al., 2003). They are the most important economic variety of the genus Phaseolus. The three closely related variety of beans such as- Red Kidney Beans (Phaseolus vulgaris l.), White Kidney Beans (Phaseolus nanus l.) and Pinto
Beans (Phaseolus vulgaris francais); all scientifically known as Phaseolus vulgaris make the mainstay of this review.

RED KIDNEY BEANS (Phaseolus vulgaris l.)

Red kidney beans (Rajmah) are also known as Kidney beans, Snap beans, Field beans, French beans, Dry beans, Pole beans etc. in different parts of the world. They are medium-large and flat kidney-shaped seeds with a deep glossy red color and cream-colored flesh. The seed has a dark red skin and is named for its visual resemblance to a kidney. (Sardana et al., 2000).

WHITE KIDNEY BEANS (Phaseolus nanus l.)

White kidney beans have various names- Boston Baked Beans or Great Northern beans, Navy beans, Cannelli in Italy; Haricot in France. They are small pea-sized, oval and creamy white in color with a refined texture and delicate flavor, noted for their milder flavor. These are commonly used as baked beans, but they are also good in soups, salads and chilli. They are so named because they were a staple food and most popular in the US as canned beans (Lu et al., 1996).

PINTO BEANS (Phaseolus vulgaris francais)

The “Pinto” bean actually got its name from the Spanish word “painted”—same as the horse and ponies, considering the bean’s reddish-brown streaking across a background of pale pink. They are also called mottled beans, are medium-sized, oval, speckled reddish brown over a pale pink base, and have a solid texture and flavor. They are common in the United States as canned, refried beans or as a dry packaged commodity (USDA, 1996).

2.2 KIDNEY BEANS AS A WORLD CROP

In fact, fossil records demonstrate that prehistoric people domesticated and cultivated legumes for food. Today, this extremely large category of beans contains over 13,000 species and is second only to grains in supplying calories and protein to the world’s population (Jangchud and Bunnag, 2001). The use of legumes as a basic dietary staple can be traced back to more than 20,000 years in some eastern cultures, while the common beans were cultivated for the first time in the earliest
Mexican and Peruvian civilizations more than 5,000 years ago. Small farms in Mexico, Brazil, Central America and Africa, account for about 80 percent of the world’s annual production. In Africa, India, Latin America and Mexico, it is the most consumed legume (Shimelis and Rakshit, 2007). The crop has been grown continuously in Southern Ontario since the 1940’s. In the 1980’s, the crop began an acreage expansion in western Canada, primarily in Manitoba and the irrigated areas of Alberta (Pulse Canada, 2003). In 2002, beans acreage and production hit record levels estimated at 218,000 hectares and 413,000 tones respectively. Turkey has about 155.000 hectares of dry beans harvesting area and 250.000 tons of dry beans production per annum with a yield of 1616 kg/ha of beans (FAO, 2004).

Dry beans (Phaseolus vulgaris) have the greatest popularity in the U.S., as well as, they have long been a part of traditional diet of most of the world’s developing countries with an annual production in excess of 100 million metric tons. They have been domesticated independently in Central and Southern America (Graham and Ranalli, 1997). But today, they are grown commercially and the largest commercial producers are India, China, arid and semi-arid areas of Pakistan, Indonesia, Brazil, United States, Mexico and Europe (Carai et al., 2009). The growing location of beans is the U.S. with Michigan, California, Idaho, Nebraska, Colorado and North Dakota, being the largest producers. Economically, beans are an important crop in North America, since their production and export has increased significantly in recent years. In Canada, navy and pinto beans are among the most produced and consumed legumes (Agriculture and Agri-Food Canada, 2006). India is a major legume producing country accounting for about 27-28 % of world legume production. Area under legume cultivation in India is 228.47 lakh hectares yielding an annual production of 130.70 lakh tones (Anonymous, 2000).

Red kidney beans (Phaseolus vulgaris l.) have been a dominant staple in the low to mid-altitudes of the America for millennia. They are widely grown in Southern Mexico, Central America, Brazil and around the great lakes in Eastern Africa (Burundi, Rwanda, Kenya, Tanzania) for its edible bean and pods. In recent years, beans are widely grown and consumed in various regions of world mainly in developing countries such as- India due to economic progress (Zafar et al.,
They are widely cultivated in the tropics, sub-tropics, temperate and semi-tropical regions. It is a part of North Indian cuisine. They are mostly grown in Northern and Central parts of India. More than 300 land races of kidney beans are grown in hilly states of Himachal Pradesh. They are also most popular in Punjab region of India (Saxena, 2009).

White kidney beans (Phaseolus nanus L.) are the best known as the beans popularized by H. J. Heinz of Pittsburgh, they have originated on the American continent, specifically in southern United States, Mexico, and northern part of South America. In particular, the species *P. vulgaris* was introduced into Europe in the sixteen century and since then it has become a very important crop in many other temperate and subtropical regions of the world (Fantini et al., 2009). It is the most important legume cultivated in Europe, Central America, and North America. Navy bean production is mainly concentrated in Michigan and the Red River Valley of North Dakota and Minnesota. It has more than hundred varieties which are traditionally grown and consumed in the hills of Uttarakhand. It got its current popular name because it was a staple food of the U.S. navy in the early 20th century (Rebecca, 1988).

The pinto beans (*Phaseolus vulgaris francais*) were cultivated for the first time in the very earliest Mexican and Peruvian civilizations more than 5,000 years ago. They are the most widely produced beans in the United States and one of the most popular in the America. In India, the production of pinto beans (*Phaseolus vulgaris francais*) is very high. It is widely cultivated in Central and Eastern regions of Uttar Pradesh. Conditions are suitable for the cultivation of pinto beans during Rabi season. Pinto beans are twining/climbing plants with relatively long stems that can be woody or herbaceous. The beans are grown as a potential rabi crop in the plains of north India. (Chandra and Ali, 1986)

### 2.3 PRODUCTION AND CULTIVATION IN INDIA

Kidney beans are traditionally a crop of temperate regions. They are widely grown in hilly tract of Jammu and Kashmir, Himachal Pradesh (Kullu, Barot, Chamba and Shimla valley) and hill of Uttar Pradesh and in some parts of
Maharastra (Mahabaleshwar and Ratnagiri region) as a kharif crop and in other parts of Maharastra, Andhra Pradesh, western and eastern Ghats' and north-east plains where winters are mild and frost free as a winter crop. While, the cultivation of kidney beans is mainly restricted to hilly regions of north India, their consumption is more in the plains of north and central India, where the demand of beans is not fully met. Recently, the cultivation of beans has begun as a potential rabi crop in the plains of north India. Possibilities of their cultivation as a rabi crop in different agro-climatic situations of Bihar have been revealed by Sharma et al. (1990). They are grown in different parts of the country for their mature dry seeds, immature/tender green or yellow pods to be used as a vegetable. Tender pods of French beans for vegetable purpose can be harvested at about 55-60 days after sowing.

Botanically, the common bean is classified as a dicotyledonous. They are highly polymorphic species, annual herbaceous, erect and bushy, 20-60 cm tall or twinning with a taproot and nitrogenous nodules. They have a wide range of seeds in shape and color; kidney-shaped seeds, white, red, spotted, pink and black. Well-drained clay loam, loam or sandy loam soils with a high percentage of organic matter and pH 5.8 to 6.5 are most suitable for beans production. The main crops should be got in early in May and a later sowing may be made early in July. Immature pods are eaten as vegetables and leaves can be used as a potherb.

2.4 CLASSIFICATION AND NOMENCLATURE:

**Kingdom** Plantae - Pants; **Subkingdom** Tracheobionta - Vascular plants; **Super division** Spermatophyta - Seed plants; **Division** Magnoliophyta - Flowering plants; **Class** Magnoliopsida- Dicotyledons; **Order** – Fabales; **Family** Fabaceae – Pea family; **Sub-family** Faboideae, **Genus** Phaseolus L.- Bean; **Species** *P. vulgaris* l., *P. nanus* l., *P. vulgaris* francais – Kidney bean.

(plants.usda.gov/java/profile?symbol=phvu)

*Phaseolus vulgaris* are also referred to as Common bean, Garden bean, Field bean in English; Rajmah, Rajmash, Bakla in Hindi; Haricot in French; Kidney and Navy in British; Bohnen in German; Frijoles in Spanish; Habas in Mexican; Feijao or Feijaos in Portuguese; Fagiolo in Italian. (Uebersax, 2006)
2.5 NUTRIENT COMPOSITION

Among all varieties, kidney beans are valuable and economical source of complex carbohydrates, dietary fiber and contribute significant amount of vitamins and minerals, and high energy value (Tharanathan and Mahadevamma, 2003). They have also beneficial effects on human health, being very low in sodium, rich in thiamine, copper, zinc, iron, potassium, magnesium and phosphorus, calcium and are cholesterol free (Iqbal et al., 2006). However, other leguminous seeds were reported to be low in lipid with percentage between 1 and 2% (Akpinar et al., 2001). Also the content of iron and group B- vitamins such as thiamine and riboflavin is rather high in these beans (Kolota et al., 2007). Minerals in beans are readily available, which are important in reducing the risks of osteoporosis (Dawson-Hughes et al., 1990) and hypertension (Appel et al., 1997). Substituting vegetable for animal protein may reduce urinary calcium excretion and reduce the risk of osteoporosis in humans. Sangronis and Machado (2007) reported significantly higher content of calcium in dry kidney beans, i.e. 350 mg/100 g of dry matter on an average. Combination of whole grains with legumes for coronary artery disease patients. In patients with diabetes mellitus, kidney beans can reduce the fasting level of glucose (Jang et al., 2001).

Table 2.5.1 Proximate content of kidney bean varieties in different studies

<table>
<thead>
<tr>
<th>Variety of Kidney Beans</th>
<th>Study</th>
<th>Moisture (g/100g)</th>
<th>Ash (g/100g)</th>
<th>Fat (g/100g)</th>
<th>Fiber (g/100g)</th>
<th>Protein (g/100g)</th>
<th>CHO (g/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Kidney Beans (RSJ-178)</td>
<td>Gopalan, 2004</td>
<td>12.0</td>
<td>-</td>
<td>1.3</td>
<td>-</td>
<td>22.9</td>
<td>60.6</td>
</tr>
<tr>
<td></td>
<td>Towo, 2003</td>
<td>12.9</td>
<td>3.7</td>
<td>1.7</td>
<td>-</td>
<td>22.4</td>
<td>63.4</td>
</tr>
<tr>
<td></td>
<td>Emiola, 2004</td>
<td>12.1</td>
<td>1.6</td>
<td>1.0</td>
<td>-</td>
<td>20.9</td>
<td>76.3</td>
</tr>
<tr>
<td></td>
<td>Khatoon, 2004</td>
<td>12.8</td>
<td>3.2</td>
<td>1.5</td>
<td>2.3</td>
<td>22.4</td>
<td>67.1</td>
</tr>
<tr>
<td>White Kidney Beans (HUR-15)</td>
<td>Maria, 2004</td>
<td>9.5</td>
<td>2.9</td>
<td>1.8</td>
<td>4.2</td>
<td>22.2</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Granito, 2002</td>
<td>10.9</td>
<td>3.9</td>
<td>1.6</td>
<td>4.3</td>
<td>22.3</td>
<td>61.3</td>
</tr>
<tr>
<td></td>
<td>Frias, 2002</td>
<td>9.9</td>
<td>4.5</td>
<td>1.5</td>
<td>3.5</td>
<td>23.0</td>
<td>58.6</td>
</tr>
<tr>
<td>Pinto Beans (PDR-14)</td>
<td>Guerea, 2002</td>
<td>8.3</td>
<td>3.9</td>
<td>1.2</td>
<td>4.3</td>
<td>22.9</td>
<td>54.6</td>
</tr>
<tr>
<td></td>
<td>Ofuya, 2005</td>
<td>10.2</td>
<td>4.7</td>
<td>1.5</td>
<td>4.2</td>
<td>20.6</td>
<td>59.7</td>
</tr>
<tr>
<td></td>
<td>Sharma, 2002</td>
<td>10.2</td>
<td>-</td>
<td>1.5</td>
<td>4.2</td>
<td>20.6</td>
<td>63.7</td>
</tr>
</tbody>
</table>
The composition of three varieties of kidney beans was given by Wang et al. in 2009: the composition of red kidney beans is 21.5-27.1% protein, 1.1-1.2% fat, 61.7% carbohydrates (36.1% starch), 7.0%-20% fiber, 3.0-4.4% ash and the composition of white kidney beans is 18.2% moisture, 21.1-24.5% protein, 1.5% fat, 39.0-56.3% carbohydrate, 6.6% crude fiber, 2.9-4.3% ash and the composition of pinto beans is 18.8-22.4% protein, 1.0-1.2% fat, 61.8% carbohydrates (42.5% starch), 6.3-18.9% fiber and 3.5-3.8% ash content. In addition, high total dietary fiber and low fat content can give benefit to people with cardiovascular disease and hypercholesterolemia (Bassano et al., 2001). In addition, folate being an essential nutrient which reduces the risk of neural tube defects and lowers the blood level of homocysteine. They have a positive co-relation with reducing the coronary heart disease risks (Mann and Chisholim, 1999). The predominant unsaturated fatty acid in beans is linoleic acid. Although, they also contains n-3 fatty acids and α-linoleic acids (Messina, 1999). Due to good source of “lente” carbohydrate and soluble fiber, they contribute to their low glycemic index, which are beneficial for diabetic individuals and reduce the risks of developing diabetes as compared to other fiber rich plant foods such as- cereal and tubers (Champ, 2001 and Mathers, 2002).

Table 2.5.2  
Mineral content of kidney bean varieties in different studies

<table>
<thead>
<tr>
<th>Variety of Kidney Beans</th>
<th>Study</th>
<th>Iron (mg/100g)</th>
<th>Calcium (mg/100g)</th>
<th>Phosphorus (mg/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Kidney Beans (RSJ-178)</td>
<td>Gopalan, 2004</td>
<td>5.8</td>
<td>260</td>
<td>410</td>
</tr>
<tr>
<td></td>
<td>Towo, 2003</td>
<td>6.3</td>
<td>187</td>
<td>444</td>
</tr>
<tr>
<td></td>
<td>Khatoon, 2004</td>
<td>5.3</td>
<td>116</td>
<td>411</td>
</tr>
<tr>
<td>White Kidney Beans (HUR-15)</td>
<td>Ejigui, 2005</td>
<td>8.6</td>
<td>233</td>
<td>502</td>
</tr>
<tr>
<td></td>
<td>Champ, 2001</td>
<td>8.3</td>
<td>265</td>
<td>308</td>
</tr>
<tr>
<td>Pinto Beans (PDR-14)</td>
<td>Ejigui, 2005</td>
<td>6.5</td>
<td>166</td>
<td>412</td>
</tr>
<tr>
<td></td>
<td>Khatoon, 2004</td>
<td>8.2</td>
<td>268</td>
<td>390</td>
</tr>
<tr>
<td></td>
<td>Champ, 2001</td>
<td>7.0</td>
<td>111</td>
<td>410</td>
</tr>
</tbody>
</table>
2.6 ANTIMUTRIENTS

Despite enormous advantages, beans are underutilized due to the presence of antinutrients, prolonged cooking time, flatulence causing agents and owing to the presence of polyphenols. They contain several anti-nutritional factors including trypsin and chymotrypsin inhibitors, hemagglutinins, tannins, alpha-amylase inhibitors and α-galactosides, phytates, saponins, lathyrogen compounds causing favism, goiterogenic factors, alkaloids and cyanogenic glycosides (Khattab and Arntfield, 2009). These can affect the overall nutritional value of beans. They also limit their consumption, effect the biological utilization of nutrients by becoming antagonists to digestion, low protein digestibility and also by interfering with the absorption of minerals. Kidney beans are relatively high in calcium, zinc and iron, but the bioavailability of these nutrients is reduced by phytate, tannins and oxalic acid constituents.

Tannins are a water soluble phenolic compound. It is an astringent, bitter plant polyphenols that either bind and precipitate or shrink the proteins. It forms insoluble complex with proteins, thereby lowering their digestibility (Carbonaro et al., 1996). It acts as a metal ion chelators and reduces the bioavailability and interferes with iron absorption through complex formation in the gastrointestinal lumen. Iron deficiency anemia has been shown to have high association with low iron availability from vegetarian diets and phytates are likely to account for the poor iron accessibility in Tanzanian diets. The higher amount of tannins present in dark colored seed coat as compared to light colored seed coat of beans and the ranged from 770-1100mg/100g to 970-1440mg/100g (Talata et al., 1998).

Phytic acid (PA) (Myoinositol hexaphosphate) represents a complex class of naturally occurring compounds that can significantly influence the functional and nutritional properties of food, found in legumes which have crucial importance. It accumulates in the seeds during the ripening period and is the main storage form of both phosphate and inositol in plant seeds and grains. In dry beans, the phytic acid accounts for about 65-85% of the total seed phosphorus (Loewus, 2002). Numerous studies suggest that phytic acid can chelate the calcium, iron and magnesium ions rendering them unavailable leads to the formation of insoluble complexes thereby
making minerals unavailable for absorption and thus limit the nutritive value of beans (Rimbach et al., 1994). It also reduces the biological availability of dietary copper, manganese, iron, magnesium and zinc turning them into insoluble form (Lucca et al., 2001). It also forms complexes with proteins and starch thus inhibits their digestion (Oatway et al., 2001). Dark colored seed coat of beans contained significantly more phytic acid as compared to light colored which had 40-57% less. According to Alonso et al., 2001; found that the concentration of phytic acid is 4.90 mg/g in raw kidney beans.

Cyanogenic glycosides (CG) have been implicated in a number of cases of acute and chronic cyanide poisoning throughout the world (Drewnowski and Gomez-Carneros, 2000). It has a special affinity for iron in its trivalent (ferric) state and is capable of binding to all enzymes, proteins and iron, including haemoglobin, myoglobin, catalase, and the cytochrome system (Uvere et al., 2000). Its most significant interaction is its binding to the ferric iron of the mitochondrial cytochrome oxidase system. This results in anaerobic metabolism, increased lactic acid production, reduced ATP stores, and anoxic cell death (Leavesley et al., 2007). The organ systems that are most sensitive to cyanide toxicity are those with the highest oxygen utilization that cannot tolerate hypoxic stress, namely the central nervous system and the myocardium (Marriott, 2000). Okafor et al., 2002, reported cyanogen content ranging from 5.88 to 28.55mg/100g in various legumes.

Trypsin inhibitor’s (TI) is a heat-labile and protein in nature which is mainly concentrated in the seed cotyledons and latter in seed coat of beans. It can inhibit the proteolytic activity of the digestive enzyme trypsin leads to reduce the bioavailability and digestibility of amino acids and some vitamins and minerals. (Adebowale et al., 2005). Red variety of beans showed a significantly higher activity of trypsin inhibitors in the cotyledons as compared to white variety which had about 50% less (Liener and Kakade, 1980).

2.7 PROCESSING PROSPECTS

Societies have been slow in accepting these nutritional nuggets owing to reasons ranging from cumbersome cooking, difficult digestion and peculiar flavor
and taste. Besides this, presence of anti-nutritional factors which can undermine nutrient utilization when the beans are consumed without adequate processing is a matter of concern. They can be eliminated or inactivated to a large degree by using appropriate different household practices such as: germination reduces trypsin inhibitors; dehulling and soaking reduces tannin content, cooking decreases the phytic acid and hemagglutinin activity due to thermo-labile in nature and oligosaccharides are also reduced (Abd El-Hady and Habiba, 2003) and recently including extrusion cooking (Mariscal-Landin et al., 2002) markedly improved the nutritional value, utilization and biological availability of legumes. However, some processing methods such as: soaking, cooking, dehulling influences the nutritional quality of beans. Soaking and cooking reduced the amount of crude protein, ether extract, crude fiber and total ash (Emiola, 2004). Some vitamins and minerals - iron, calcium, may also lose due to leaching of these compounds in the soaking water along with flatulence-causing oligosaccharides. Soaking reduced the protein due to leaching of soluble proteins, or hydrolysis into simpler compounds, thus increasing the digestibility of proteins. They also reduced the fat content due to lipolytic enzyme activity which breakdown the triglycerides into simpler fatty acids, sterols, esters and polar lipids. Conversely, other researchers have reported increased moisture content after soaking of all legumes. Rehman et al. (2001) reported that soaking significantly reduced the total sugars and starch content of kidney beans. El-Hady and Habiba (2003) observed that 36% reduction of phytic acid in kidney beans after an overnight soaking in water at room temperature. Germination notably reduces phytic acid and tannin content which has been attributed to the formation of hydrophobic association of tannins and phytic acid with seed proteins and enzymes. Trypsin inhibitors and phytic acid were steadily degraded during the sprouting period. Fermentation is also a beneficial household technique to achieve desirable changes in the seed composition and to improve palatability. It enhances the nutritive value and reduces the oligosaccharides and exerts beneficial effects on protein digestibility and biological value of legumes (Mbiti-Mwikya et al., 2002). ElMaki et al. (2007) studied the effects of soaking on anti-nutritional factors of white kidney beans and found that phytic acid contents of all cultivars were reduced. Heat treatment has been generally attributed to the
destruction of protease inhibitors and lectin thus increases the nutritive value of beans and protein digestibility. Soaking to hydrate the beans prior to heating, therefore, is a very important step to effectively inactivate proteinaceous inhibitors such as trypsin inhibitors and lectins. Ramakrishna et al. (2006) and Shimelis and Rakshit (2007) found that trypsin inhibitors activity was reduced in kidney bean through hydration. Khat tab and Arntfield (2009) showed that soaking of cowpea, pea and kidney beans significantly reduced the trypsin inhibitor activity. The combined treatment of soaking and dehulling significantly (p<0.05) affected the trypsin inhibitor activity in the beans. Similar findings were obtained by Mubarak (2005) for mung bean seeds and Wang et al. (2009) for lentils. Several investigators have reported that soaking reduced the raffinose and stachyose levels in cowpeas (Vigna unguiculata) (Onyenekwe et al., 2000). Soaking, germinating, heating, fermentation and enzymatic treatment have been suggested to reduce the oligosaccharides in beans to mitigate the flatulence problem (Siddhuraju and Becker, 2001).

2.8 NOURISHING POTENTIAL

Dry legume seeds constitute an important part in the diet of large segments of the world population, especially those living in technically underdeveloped tropical and subtropical areas where animal protein consumption is relatively small due to its scarcity or cultural taboos. For centuries, dried beans and other pulses have served as a primary protein source for many cultures. Among all varieties, kidney beans are an important and relatively inexpensive source of protein (22.9%), energy (846%), dietary fiber, vitamins, minerals (3.29%) and bioactive compounds (Nyombaire et al., 2007). They are characterized by high protein content (17-43%) that places them second in importance to cereals (Soral-smietana and Krupa, 2005). Utilization of Rajmah can be further increased by popularizing its potential and used as a substitute for other legumes in Indian Cuisine. Consequently, research on legumes is needed for increasing the yield and improving the quality as well as quantity of proteins. Beans and grains have symbiotic relationship in terms of amino acid balance which is complement to each other in such ways as to form a complete protein, which is the foundation for the growth and development of many life forms,
including humans. But, their nutritional limitations are mainly due to deficiency of sulphur-containing amino acids such as methionine and cysteine which account for their poor biological quality but on the other hand, bean protein is rather rich in lysine (Mc Nab, 1994). Protein content in legume grains ranges from 17% to 40%, contrasting with 7–13% of cereals, and being equal to the protein content of meat (18–25%) (de Almeida Costa et. al., 2006). The protein quality could be improved by complementing the amino acid in beans through mixing with cereals or other proteins with soybeans, semolina flour and sesame has shown positive effects on biological value of proteins and provides all necessary amino acids for vegetarians. Common examples of such combinations are dal with rice, beans with corn tortillas, tofu with rice, and peanut butter with wheat bread especially for Indians. It is a good effort to compensate deficient nutrient and provides an excellent source of balanced amino acid composition.

Protein-energy malnutrition is among the most serious problems in tropical developing countries are facing today. This can be attributed mainly to the ever-increasing population as well as to the enhanced dependence on a cereal – based diet, scarcity of fertile land and degradation of natural resources (FAO, 2000). It has been estimated that 800 million malnourished people exist in some of the least developed countries. This has necessitated exploration alternate sources of protein to bridge the gap for protein requirement of the various section of vegetarian population. In this context, alternate sources like untraditional legumes (under exploited/ tribal pulses) assume significance (Myers, 2002). It is to this end that intensive efforts are being made to find alternative sources of protein from the underutilized leguminous plants in nutrition and in the formulation of new food products (Katharine, 2002). For improving protein, cereal and pulse combination strategies could be used to innovatively develop fully different recipes from kidney beans and cereal combinations.

2.9 HEALTH ENHANCING EFFICACY

Kidney beans provide health benefits. Besides, preventing and managing certain diseases and disorders, kidney beans intake in regular diet. Various potions
and extracts of these beans are used to treat diseases through alternative medicinal system.

2.9.1 Disease Prevention and Management

During the past 25 years, the health benefits of beans have become increasingly apparent. After having an insight into the nourishing attributes, other health promoting facets have not stopped coming to the lime light. They have been associated with numerous other health benefits including reduction of heart (Bazzano and Ogden, 2001) and renal diseases risks, cataracts, relieve constipation, improve gastrointestinal integrity (Bourdon et al., 2001), stabilize blood sugar, brain and immune dysfunction. Consumption of dry beans has been linked to reduced risk of diabetes with beans lowering the glycemic index in those persons with diabetes and obesity. Due to markedly alternating effects of beans on blood sugar and insulin response, their potential use for the prevention and control of diabetes, provide metabolic benefits that aids in weight control. A dietary intervention to reduce heart disease risk includes attention to consumption of types of fatty acids, dietary fiber, isoflavones and antioxidantsrich dry beans (Klevay, 2002). It has been reported that diet supplemented with dry beans lowers the serum total cholesterol by as much as 19% and low density lipoprotein (LDL) cholesterol by 24%. Pinto bean consumption reduced total and LDL blood cholesterol concentrations in hypercholesterolemic subjects (Winham and Hutchins, 2007) because of richness of soluble fiber in beans which are fermented in the colon and generate short chain fatty acids (SCFAs) may hinder hepatic cholesterol synthesis. Soluble fiber and resistant starch in beans suppress appetite (Howarth et al., 2001) and lower the risk of colorectal cancer (Higginbotham et al., 2005). Epidemiological studies confirm the highly significant inverse co-relation between bean intake and age-adjusted mortality for breast and prostate cancers (Adebamowo et al., 2005). As per a recent analysis of more than 183,000 subjects enrolled in the Hawaii-Los Angeles Multiethnic cohort study revealed that high intake of beans was associated with a significantly lower the risk of prostate cancer (Kolonel et al., 2009) and pancreatic cancer among overweight and obese individuals (Nothlings et al., 2007). Efficacy of a bean-based diet has been shown to improve the growth and
development and slow the progression of AIDS in the group of HIV-positive childrens in Bostana (Jackson et al., 2006). They may be a desirable alternative to wheat flour products, especially for those afflicted with celiac diseases due to gluten free in nature.

2.9.2 Anti-Aging Role

Compared with more commonly consumed grains or legumes, beans have been somewhat overlooked (Madar and Stark, 2002). They have ‘anti-aging agents’ that quench the free radicals such as flavonoids, lignin’s, phenolic acids exhibit a wide range of biological effects including anti-bacterial, anti-viral, anti-inflammatory, anti-allergenic (Mather, 2002). Free radicals induced oxidative damage are believed to lie at the heart of the etiology of a number of diseases including certain types of cancers, cardio-vascular disease and neurodegenerative diseases such as Alzheimer and Parkinson diseases (Cai, 2004). Epidemiological studies have shown the co-relation between the consumption of food with a high content of phenolics such as grains, legumes etc. and decreases the incidence of several degenerative diseases (Kris-Etherto et al., 2002). Several recent studies have reported that legumes with a dark colored seed coat such as Red kidney beans, pinto beans, lentils possess a higher antioxidative activity due to the presence of high amount of phenolic compounds mainly anthocyanins, flavonol glycosides than the white varieties (Madhujith and Shahidi, 2005). The physiological effects of dry bean consumption may be due to the presence of abundant phytochemicals that include polyphenolics, which possess anti-carcinogenic, antioxidant (Cardador-Martinez et al., 2002) and anti-inflammatory (Wu et al., 2004) and antimutagenic properties (Hangen and Bennink, 2002) as well as an antiproliferative effect on transformed cells which decreases the risk of coronary diseases and remove carcinogens from the body (Aparicio-Fernández et al., 2006). Saponins, a class of phytochemicals found in beans, may help reduces the risk of lung and blood cancers (Leterme, 2002). A recent study shown that the consumption of beans and lentils is related to lower the incidence of breast cancer due to higher antioxidant and phenolic compounds. They are also an abundant source of inositol hexaphosphate, an antioxidant compound which is helpful in preventing the cancer and control the
growth, progression and spread of tumors in humans (Vucenik and Shasuddin, 2006).

2.9.3 Role of Kidney Beans in Alternative Medicine

Beans are an often overlooked source of incredible health and medicinal benefits and have different parts of plants are used in many ways-

Kidney beans bruised and boiled with garlic, cured intractable coughs (www.naturalmedicinalherbs.net/herbs/P/Phaseolus-vulgaris=french-bean.php).

Prolonged use of decoction made from kidney beans is used in the treatment of various skin diseases such as- acne, eczema, eruptions and itching, sores (www.health-from-nature.net/Bean-common.html). Kidney beans also have hypoglycemic and hypotensive effects. Its ground into flour and used in the treatment of ulcers and blood cancer(www.liveandfeel.com/medicinalplants/bean. html). Kidney beans are also used as a homeopathic remedy made from the entire fresh herb. It is used in the treatment of rheumatism and arthritis plus disorders of the urinary tract (www.health-from-nature.net/Bean-common.html). It has been claimed that kidney beans act as a laxative. Green pods of kidney beans used as a mild diuretic that reduces the blood sugar level and can be used for mild cases of diabetes(www.naturalmedicinalherbs.net/herbs/P/Phaseolus-vulgaris= french-bean.php). Dried pods of kidney beans used in conjunction or rotation with other efficacious herbs and can be taken alone or mixed as a tea and useful for dropsy, sciatica, chronic rheumatism, kidney and bladder problems, uric acid accumulations and loss of albumin in the urine during pregnancy (www.medicinalherbinfinfo.org/herbs/Bean.html).

2.10 PRODUCT DEVELOPMENT

Product development is a combination and application of natural sciences with the social sciences - of food science and processing with marketing and consumer science - into one type of integrated research whose aim is the development of new products (Winger and Wall, 2006). It is a standardized and tested procedure for preparing food, in which the ingredients to be used, their
proportions, order of mixing and the time and temperature for cooking have all been worked out to produce a uniform and tasty products. The recipe itself is a blueprint for food production. In business and engineering, new product development (NPD) is the term used to describe the complete process of bringing a new product or service to market. Carelessness in measurements and variations in preparation procedures and equipment can create changes in the final product, which are usually undesirable and thus the whole exercise has to be systematic, precise and based on principles of food science. Product development needs to be carried out by exploring the nutritious recipes at household level and it should increases the cooking quality along with improvement in palatability and nutritional quality, becoming free from antinutritional factors. For improving protein quality, cereal and pulse combination strategies could be used to innovatively develop different recipes. The developed recipes would be known for their wholesomeness, high nutritional value, delicacy and high calorific value. The main objective of product development is "tailoring" a recipe to suit a particular purpose in a specific foodservice operation. A well-developed recipe must meet a number of needs such as: (i) to increase the visibility of product; (ii) to increase product usage; (iii) to minimize safety problems of product; (iv) to promote existing products ;(v) to satisfy the consumer demands; (vi) to overcome the health related problems of society; (vii) to fulfill the priorities of society.

There could be various recipes for the preparation of foods of plant origin. However, attention needs to be focused on those recipes where the original product is either improved with respect to nutritional value or sensory quality. Nutritional value is usually improved by restoration, fortification and enrichment using kidney beans, soybeans, cowpeas and other legume flours which increase protein content and complement amino acid profiles of cereals, roots and tubers, fruits and vegetables and their products. As they are traditionally consumed as whole beans and its flour, the practices can be used in the preparation of more diverse Indian delicacies after appropriate household processing. Bean protein has also been used in combination with cereals, as a nutritious weaning food. They can be used for making a wide variety of snacks, soups, curries and sweet items. **Punia and Gupta**
in 2009 developed four value added products namely soya ladoo, paushtik ladoo, sev and mathri, preparing them from locally available food ingredients such as soybean, green leafy vegetables, peanuts, and sesame seeds in various food products. Theresults reveal that all the developed value-added products are highly acceptable having an average score of more than 4 on 5-point basis. The developed value-added products can be a good supplement for children to meet the nutritional requirements during the growing phase of life.

As these have Kaushik and Mathew (1988) prepared some products according to physiological conditions- pregnancy and lactation has a direct influence on infant's health status. Four different supplementary food items--ajwain ka laddu, gond ka laddu, haldi laddu and soth ka laddu were developed and widely consumed by lactating women in ball form. In short, the product development focus has to be on to making value added products.

Another study conducted by Muyonga in 2008 which was based on the substitution of amaranth in some conventional snacks which was commonly consumed by children in Uganda. Acceptable cakes and cookies have been developed with amaranth making up to 70% of the flour used. In other products such as baggia (a snack made by cold extrusion of dough followed by deep frying) and kabalagala (a snack made by rolling dough into a flat shape, cutting into a round shape and then deep frying), acceptable products were made with 100% amaranth flour. Cookies, cakes and baggia are normally made from wheat flour while kabalagala is usually made from maize flour. By substituting the wheat or maize flour with amaranth, the protein content and quality as well as the iron, zinc, calcium and B-vitamins content of the snacks were improved. Results revealed that amaranth has the potential to contribute to the improvement of the nutritional status of vulnerable populations such as children and the sick.

The formulation and development of nutritional weaning foods from local and readily available raw materials has received a lot of attention in many developing countries (Ijarotimi and Aroge, 2005). Cereals form the major part of most weaning mixes and contribute to 70-80% of daily energy intake (Mahajan and
Chattopadhey, 2000). However, they are deficient in one or two essential amino acids and need blending with legumes for improving of protein quality through mutual supplementation (Sastri et al., 1991).

Children in most developing countries are introduced directly to the regular household diet made of cereal or starchy root crops. Inadequate complementary food is a major cause for the high incidence of child malnutrition, morbidity and mortality in many developing countries. In developing countries, foods are rarely modified at the household level to increase nutrient density to meet the needs of infants. Traditional foods made of cereals or tubers may be low in several nutrients including protein, vitamin A, zinc and iron; these nutrients are of special importance due to their impact on physical and cognitive development. One of the study conducted by Sharma in 2011, three supplementary products- sweet dalia, salty dalia and khichdi were prepared using broken wheat and rice as control while for test samples broken wheat was used for both sweet and salty dalia. They were supplemented with oats at 20 percent, 25 percent and 30 percent levels. The developed products were found organoleptically acceptable. Supplementation of products with oats increased the protein, crude fiber, and fat content in comparison to the normal preparations.

Green leafy vegetables contain around 2-7 percent of protein (Rao et al., 1989), 0.09 to 40 mg/100g of iron and carotene ranging from 120 to 14190 μg/100g (Gopalan et al., 2004). On one hand, ample amount of green leafy vegetables are available in the country and on the other micronutrient deficiencies are rampant especially of Iron Deficiency Anemia (IDA) and Vitamin A Deficiency (VAD). The major reason for their occurrence brings a lowered consumption of this group of quality foods among vulnerable population. IDA is one of the major public health problems of the country among women of reproductive ages. Prevalence of anemia among rural adolescent girls of Dharwad was found to range from 73 to 87 per cent (Hanagi, 2001) and 63 to 85 percent among urban girls (Deepa, 2002).

Nambiar and Parnami(2007) standardized some traditional Indian recipes with drumstick (moringaolifera) leaves. Freshly blanched drumstick leaves were incorporated in three pulse based recipes commonly consumed in India such as mung (phaseolus aureus), Kabuli chana (Cicer arietinum) and desi chana (Cicer aritinum). One serving of each of these recipes (30 g raw weight of pulses which is
equivalent to approximately 100 g cooked weight) could blend with a maximum of
20 g of fresh drumstick leaves. The study showed that all the three recipes (mung,
Kabuli chana and desi chana) were found to be acceptable by the panel of judges
with an overall composite score on 5 point basis.

Begum et al. (2003) carried out experiments on nutritional enhancement of
common convenience foods such as papads by substituting conventional grains with
nutritious millets. Acceptable papads were formulated using Finger millet (60%),
sago (20%), black gram (20%) and spices. Calcium content was observed to be
exceptionally higher in papads with Finger millet (156 g/100 g) as compared to
traditional papads (82 mg/100 g).

Cereals and legumes, in general, play an important role in human nutrition.
Recent studies have shown that cereals and beans contain constituents that have
health benefits for humans, such as antioxidants and anti-disease factors (Ragaee
et al., 2006). Generally, cereals and legumes, such as red kidney beans, soy and corn,
have been used to make highly nutritious products (Baskaran and Bhattacharaya,
2004).

Some traditional household food preservation and preparation practices such
as fermentation favor micronutrient retention or enhance bioavailability of some
nutrients and are important components of food product development. A study done
on product development by Shah and Sail, 2005 in whichmoth bean vada were
prepared from fermented batter of moth bean flour. Results indicated increase in
thiamine and riboflavin content on fermentation, which decreased slightly on
cooking. Increase in vitamins on fermentation due to bacterial synthesis was also
reported by Zamora and Field (1979). In a study Bhama and Sadana (2004)
reported that dehulling of legumes decreases the calcium content. Iron content of
processed Bengalgram dhal based products was found to be decreased significantly,
whereas fermented vada showed 14.3% increase in iron content. The process of
fermentation leads to an increases in the nutritive value of products.

A multitude of investigations have demonstrated the beneficial
hypoglycemic effect of millets, fenugreek seeds and legumes in diabetic subjects.
However, the bitter taste of fenugreek seeds and coarse nature of millets have been
limitations in using them in daily dietaries. Moreover, as of today, the availability of
special foods for diabetics in the Indian market is negligible. The millets, fenugreek seeds and legumes in judicious combination, after suitable processing, were used to formulate three nutritious food products - dhokla, uppuma and laddu, which are popular traditional snack foods in India. Evaluation of these food products for glycemic response in five normal and five diabetic subjects showed hypoglycemic effects in terms of glycemic-index (GI). These food products may have an important role in dietary management for diabetic people and may cater to their needs on a large scale if commercialized. (Pathak et al., 2000).

All in all, the potential for nutritional benefits lies in legitimate food product development. The addition of food legumes into mainstream diets in the form of flour and is proving a popular approach for consumers and food developers alike.

2.12 SENSORY EVALUATION

It has been recognized that enjoyment of food is essential for good health. Enjoyment would mean choice and acceptance along with nutrition and wholesomeness. This acceptancenaturally depends primarily on those qualities we can perceive and experience. The various attributes- color, appearance, taste, texture and aroma of food which are the sensory responses of the consumer to the food. For assessing the acceptability of any food product sensory evaluation play a very critical role.

"Sensory" is derived from the Latin "sensus" (sense) and therefore, "sensory evaluation" is a scientific discipline used to evoke measure, analyze and interpret results of those characteristics of food and materials as they are perceived by the sense of sight, smell, taste, touch and hearing. It is an analytical method in which the human senses serve as a measurement tool to determine the quality and/or to describe the condition of a food product. It requires panels of human assessors, on whom the products are tested, and recording the responses made by them. Prerequisites for the success of this analytical process include: standardization of methods, regular training and performance measurement of testers, a statistical evaluation of test results; and a standardization of terms. One main objective of sensory evaluation is the measurement of sensory attributes and the quantification of the influence of those attributes on consumer acceptance. Sensory evaluation is conducted in a formal manner by laboratory and consumer panels. Trained assessors
comment on the appearance, color, texture, taste and flavor of the product being
developed. The sensory testing requires human judges who were selected by using
triangle difference test. When a new product is developed, it becomes necessary to
check its acceptance. By applying statistical techniques to the results it is possible to
make inferences and insights about the products under test. Most large consumer
goods companies have departments dedicated to sensory analysis.

In a nut shell, sensory analysis can generally be broken down into three sub-
sections: (i) Effective testing (dealing with objective facts about products); (ii)
Affective testing (dealing with subjective facts such as preferences); (iii) Perception
(the biochemical and psychological aspects of sensation).

(www.unaab.edu.ng/attachments/457-NTD%20401.pdf)

2.12 EPILOGUE

Today, we have a wide range of legumes available to include in the diet, but
for historical and cultural reasons people have been eating only a few kinds of them.
Beans are also one of the oldest things around and one of the first wild plants to be
domesticated. The combination of indisputable health benefits and incredible variety
of flavors and textures ensures the bean’s have a prominent place at the modern
table. Kidney beans are relatively high in protein (24 g/100g), dietary fiber, vitamins
and minerals- calcium (284 mg/100g) and iron (5.1 mg/100g). They are also rich in
phytochemicals, polyphenols and other antioxidative compounds and also have
bioactive principles with health enhancing effects. In many developing countries, the
protein deficiency in the human diet ranks next to the deficiency in the dietary
calories. Kidney beans could become a valuable source to strengthen the nourishing
ability of traditional cereal-legume combine meal pattern of Indian dietaries. They
could be used to increase the nutritional potential of Indian diet by incorporating
them in different recipes and making nutritionally rich and taste wise acceptable
products for various life stages and disease conditions. This can go a long way in
alleviating deficiencies and improving the nutritional status of teeming millions of
impoverished- undernourished kind. They must also reach the common people
ticking their pallets, nourishing and healing their bodies through the analytical and
product development endeavors of food scientists and nutrionists.