CHAPTER III
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Methodology Road Map

Procurement of Kidney bean varieties [Red Kidney beans (RKF-178); White Kidney beans (HUR-15); Pinto beans (PDR-14)]

Household Processing

Raw Blanched

Proximate Analyses
- Moisture
- Ash
- Fat
- Fiber
- Protein
- Carbohydrates

Mineral Analyses
- Calcium
- Iron
- Phosphorus

Antioxidant Analysis
- Phenols

Antinutrient Analyses
- Tannins
- Phytic Acid
- Total Cyanogens
- Trypsin Inhibitor Activity

Food Product Development
- Selection of Recipes
- Standardization of Recipes
- Preparation of Variants
- Sensory Evaluation

Data Analysis
- Mean
- Standard Deviation
- Student’s t-test

Fig. 3.1 Road Map of Methodology
Methodology is logic of scientific investigation and it is procedure involving research techniques. Methodology means description, explanation and justification of methods. The present study deals with the analysis of chemical composition of raw and processed kidney bean varieties and product development related to different age-groups and various diseases. The purpose of this chapter is to describe how the results were obtained. Thus, this chapter contains relevant information pertaining to materials and techniques used other methodological aspects of study and how the data was analyzed.

The methodological aspects of the study, depicted in the experimental design have been discussed as under:

3.1 SELECTION OF KIDNEY BEAN VARIETIES

Three varieties of Kidney beans were selected for the study. These varieties were RSJ-178 (Phaseolus vulgaris l., Red Kidney Beans), HUR-15 (Phaseolus nanus l., White Kidney Beans) and PDR-14 (Phaseolus vulgaris francais, Pinto Beans) which were procured from Rajasthan Seed Corporation, Jaipur and Indian Institute of Pulse Research (IIPR), from Kanpur (U.P.) after due certification.

3.2 PROCESSING OF KIDNEY BEAN VARIETIES

Procured kidney beans of each variety were thoroughly cleaned, fried from dirt and foreign matter. Thereafter, they were graded and whole seeds were kept separately for analysis and the rest discarded. Then, the beans of each variety were divided into two portions. One portion of the beans was ground to a fine powder or flour and the other portion of beans were processed by giving the following treatments.

3.2.1 Hot-Water Blanching:

Another portion of beans of each variety were taken and soaked separately in boiled distilled water at 95°C into the ratio of 1:5w/v for ½ hour in beaker. Mixed with spoon to 2-3 times and left for 30 minutes. After half an hour, the water was decanted. Then, beans were washed with fresh water and soaked overnight at room temperature. Next day, water was drained and beans were
dehulled manually and dried in direct sunlight properly so as to make them moisture free. Then, dried beans were ground into powdered form and stored in air tight containers. Flour of each variety of kidney beans was subjected to further treatment and analysis.

3.3 PROXIMATE ANALYSES

3.3.1 Moisture (A.O.A.C, 2005)

**Principle:** It is based on drying up the fresh sample on continuous basis in an oven at 100-125°C to a constant weight.

**Procedure:** 10 gram of sample was taken and dried in an oven to a constant weight. The weight was taken every half an hour after cooling the sample till two consecutive readings become constant.

**Calculation:**
\[
\text{Moisture (g/100g)} = \frac{\text{Initial weight (g)} - \text{Final weight (g)}}{\text{Weight of the sample (g)}} \times 100
\]

3.3.2 Ash (Raghuramulu et al., 1983)

**Principle:** When food sample is subjected to high temperature (600°C) for 4-5 hours in muffle furnace, organic matter burns getting converted into gases but the mineral elements remain intact and weighed as mineral ash.

**Procedure:** 10g sample was charred in a crucible and kept in the muffle furnace for 4-5 hours at 600°C. The final reading was noted down after completion of ashing process.

**Calculation:**
\[
\text{Ash (g/100g)} = \frac{\text{Weight of the ash (g)}}{\text{Weight of the sample (g)}} \times 100
\]

3.3.3 Fat (Raghuramulu et al., 1983)

**Principle:** Addition of amyl alcohol, heating and centrifuging bring the fat into the calibrated part of the tube and the fat content read directly.
Procedure: 2g of sample in weighed beaker containing thimble was taken and the entire beaker was loaded with 80ml of solvent at 20°C for 60 minutes. After the process time, temperature was increased to 120°C and rinsed 2-3 times to collect the remaining fat present in sample. Thereafter, the beaker was kept in an oven at 100°C for 30 minutes and reading was noted.

Calculation:
\[
\text{Fat (g/100g)} = \frac{W_2 - W_1}{\text{Weight of the sample (g)}} \times 100
\]

\(W_2=\) weight of empty beaker; \(W_1=\) weight of beaker with sample

3.3.4 Fiber (Raghuramulu et al., 1983)

Principle: It is made by subjecting the foodstuff acted upon by a dilute mineral acid and alkali and thereafter, measuring the weight of the crude fiber.

Procedure: Weighed fat free sample was taken in a crucible and placed in the Fibra Plus system. Then, 150 ml of 1.25% H\(_2\)SO\(_4\) was procured at 500°C. After boiling starts, temperature was reduced to 400°C. After 45 minutes, acid was drained and washed twice by distilled water. For alkali wash, same procedure was followed as for acid but 1.25% NaOH was used. The crucible was kept in an oven at 100°C until freed from moisture and weighed (\(W_1\)). After that, crucible was kept in the muffle furnace at 400°C for ashing for 4-5 hours and weighed (\(W_2\)).

Calculation:
\[
\text{Fiber (g/100g)} = \frac{W_1 - W_2}{\text{Weight of the sample (g)}} \times 100
\]

\(W_1=\) weight of crucible after oven drying; \(W_2=\) weight of crucible after ashing

3.3.5 Protein (Raghuramulu et al., 1983)

Principle: It depends on the fact that organic nitrogen when digested with sulphuric acid in the presence of catalyst is converted into ammonium sulphate. Ammonia liberated by making the solution alkaline is distilled into a known volume of standard acid, which is titrated.
**Material and Methods**

**Procedure:** *Digestion:* The sample was digested in the digestion chamber preheated to 350°C using 3g of catalyst mixture [5:1(potassium sulphate : copper sulphate)] and 10 ml of conc. H₂SO₄ till it became colorless and thus free of all organic matter. *Distillation:* 25ml boric acid with an indicator in a conical flask was placed at the receiver end. The sample was diluted at the distilled water (dilution 10ml to 20 ml) and 40ml of the 40% alkali (until dark brown color appears) was added. During the process, liquid ammonia was collected in the boric acid due to which color was changed. The conical was removed and titrated. *Titration:* The sample was titrated against 0.01 N HCl and the titrable value (TV) was noted down.

**Calculation:**

\[
\text{Nitrogen N (\%) = } \frac{14.01 \times 0.1 \times (TV-BV)}{W \times 1000} \times 100
\]

\[
\text{Protein (g/100g) = } \% \text{ N } \times 6.38
\]

14.01= Ammonia’s molecular weight; 0.1 N=HCl normality; TV= Titrable value; BV= Blank value; W= sample weight.

**3.3.6 Carbohydrate (Gopalan et al., 1989)**

**Principle:** It is based on subtraction of all proximate principles except carbohydrate from total weight to get the carbohydrate content by difference.

**Calculation:**

\[
\text{Carbohydrate (g/100g) = 100 - } \% (\text{Moisture + Ash+ Protein + Fat + Fiber})
\]

**3.4 MINERAL ANALYSES**

*Method of preparation of aliquots for mineral analyses:* The ash was washed with a small amount of distilled water (0.5 to 1.0 ml) and 5ml diluted HCl was added to it. The mixture was evaporated to dryness in a boiling water bath. Another 5ml of HCl was added again and the solution evaporated to dryness as before. 4ml of HCl and few ml of H₂O were then added and the solution was washed over a boiling water bath and was filtered into 100ml volumetric flask using whatman no. 40, made up
the volume to 100ml. Suitable aliquots were used for the estimation of calcium, iron and phosphorus.

3.4.1 Calcium (Sharma, 2007)

**Principle:** Calcium is precipitated as calcium oxalate and the same is titrated with standard KMnO4 in the presence of dilute HCl following redox reaction in which KMnO4 act as a self indicator.

**Procedure:** 40-50 ml of aliquot was taken then 5 ml of conc. HCl was added and volume made to 100 ml with distilled water. Ammonium hydroxide added till red litmus paper changed to blue and vice versa by adding conc. HCl. Then 5 ml of 5% oxalic acid, 9% ammonium oxalate and 8ml of 20% sodium acetate were added and kept overnight after shaking. Solution was filtered and precipitate was washed with 5 ml of hot distilled water and 5 ml of 1N H2SO4. Then it was titrated against 0.01N KMnO4 to the persistence of faint pink color.

**Calculation:**

\[
\text{Calcium (mg/100ml) = } \frac{S - B}{X} \times 0.2004 \times 100
\]

S = volume (ml) KMnO4 used for sample titration; B = volume (ml) KMnO4 used for a blank; X = volume (ml) of an aliquot of sample.

3.4.2 Iron (Raghuramulu et al., 1983)

**Principle:** Iron (Fe) is determined spectrophotometrically making use of the fact that ferric iron gives a blood red complex with potassium thiocyanate whose intensity is measured at 540nm.

**Procedure:** 6.5ml of aliquot of the mineral ash solution was taken in a test tube followed by addition of 1ml of 30% conc. H2SO4 and1ml of potassium per sulphate solution. Then, 1.5ml of 40% potassium thiocyanate was added just take the reading. Ferrous ammonium sulphate standard was run along with sample. The red color developed was measured within 20 minutes at 540 nm.
Material and Methods

Calculation:

\[
\text{Iron (µg/100ml)} = \frac{\text{Optical density of test}}{\text{Optical density of standard}} \times \frac{\text{conc. of std.}}{6.5} \times \text{Dilution Factor} \times 100
\]

3.4.3 Phosphorus (Sharma, 2007)

**Principle:** Phosphate containing solutions are treated with molybdic acid to produce phosphomolybdic acid, which is reduced by the addition of ANSA to give blue color measured by spectrophotometer at 700nm.

**Procedure:** 2.5 g sample was weighed in flask and marked as test (T), another flask as blank (B). 25ml of acid mixture 3:2:1 (conc. nitric acid: conc. perchloric acid: conc. sulfuric acid) and glass beads were added to each flask. For 8-10 hours it was kept in a fume cupboard. Thereafter, heated for 4-5 hours, until most of the yellow nitrous fumes were removed by white fumes of perchloric acid and then transferred with 3-4 washings of deionized water and made the volume to 10 ml. Contents were centrifuged and suitable aliquot of solution, containing 10-15µg of phosphorus was taken and volume made to 4 ml with double distilled water and the tube marked as test (T). 1.5 ml of double distilled water was added to 0.5 ml standard phosphorus solution, marked as (S). The blank (B) test tube was prepared by adding 4 ml of double distilled water. 1 ml of ammonium molybdate and 0.2 ml of ANSA solution were added to each tube and read extinction at 700nm.

**Calculation:** Standard curve was plotted by using standard solution of dihydrogen sodium phosphate. Phosphorus content in mg/100mg of aliquot was determined.

3.5 ANTIOXIDANT ANALYSIS

3.5.1 Phenols (Singleton and Slinkard, 1977)

**Principle:** Phenol reacts with phosphomolybdic acid in the Folin-Ciocalteau reagent in alkaline medium and produce blue colored complex (molybdenum blue).

**Procedure:** The finely grounded sample (2g) was extracted with 5-10ml of 80% alcohol in a pestle mortar and the homogenate was boiled in water bath for 5-10 mins, centrifuged and supernatant was collected in the same flask and volume made up. Samples (200 ml) were introduced into test tubes, and then 1.0 ml of Folin-
Ciocalteau’s reagent and 0.8 ml of sodium carbonate (7.5%) were added. The absorbance of all samples was measured at 760nm after incubating at 30°C for 1.5 hrs.

**Calculation:** Total free phenol content was expressed as mg/g sample. Standard curve was drawn by plotting the absorbance against concentration of gallic acid.

### 3.6 ANTINUTRIENT ANALYSES

#### 3.6.1 Tannins (Price et al., 1978)

**Principle:** The vanillin reagent will react with any phenol that has an unsubstituted resorcinol or phloroglucinol nucleus and forms a colored substituted product which is measured at 500nm in a spectrophotometer.

**Procedure:** 1gm of sample was extracted with 10ml of 1% HCl in methanol for 24 hours at room temperature then centrifuged at 5,000 rpm. Vanillin HCl reagent was prepared by mixing prior to use equal volumes of 8% HCl in methanol with 2% vanillin in methanol. One ml of supernatant was mixed with 5ml of Vanillin-HCl reagent. Catechin standard was run along with the sample. The absorbance was read at 500nm after 20 minutes incubation at room temperature.

**Calculation:**

\[
\text{Tannins (mg/100g) = } \frac{\text{Optical density of test}}{\text{Optical density of standard}} \times \frac{\text{conc. of std.}}{\text{volume of extract}} \times \frac{1000}{\text{weight of sample}}
\]

#### 3.6.2 Phytic Acid (Davies and Reid, 1979)

**Principle:** The phytate is extracted with trichloroacetic acid and precipitated as ferric salt. The iron content of the precipitate is determined colorimetrically and the phytate phosphorus content calculated from this value assuming a constant 4Fe:6P molecular ratios in the precipitate.

**Procedure:** One gram of dried powdered sample was taken and extracted with 3% TCA by continuous shaking, filtered and made up to suitable volume with water. To 1.4ml of the filtrate, 1ml of ferric ammonium sulfate solution (21.6mg in 100 ml water) was added, mixed and placed in a boiling water bath for 20 minutes. The
contents were cooled and 5ml of isoamyl alcohol was added and mixed. To this, 0.1ml ammonia solution was added, shaken thoroughly and centrifuged at 3,000 rpm for 10 minutes. The alcoholic layer was separated and color intensity was read at 465nm against amyl alcohol blank after 15 minutes. Standard Fe (NO$_3$)$_3$ was run along with the sample.

**Calculation:** Graph of standard was plotted and results were expressed as mg phytic acid/100g of dry weight.

### 3.6.3 Total Cyanogens (Vogel, 1996)

**Principle:** When a solution of silver nitrate is added to a solution containing cyanide ions, a white precipitate is formed which redissolve on stirring forming a stable complex cyanide, the alkali salt of which is stable. Further addition of silver nitrate solution yields insoluble silver cyano argenate. The end point of reaction is therefore indicated by the formation silver iodide in the form of a permanent precipitate or turbidity.

**Procedure:** 5 g of sample was taken in a glass stoppered flask and 50ml of 1% HCL-methanol was added. It was stoppered and kept overnight. After filtration, 25ml of extract were taken in a conical flask and 75ml of distilled water was added. Then 5ml of ammonium chloride was added, and lastly, 2ml of 10% potassium iodide solution was added in a flask. The flask was kept on a sheet of black paper and titrated with standard 0.002M silver nitrate solution. When one drop gave permanent turbidity, end point was reached.

**Calculation:**

\[ \text{Concentration (mg/Lt)} = \text{calculated normality} \times 27.01 \text{ mg/Lt (eq. wt.)} \]

\[ N1V1 = N2V2 \]

Where,  
\( N1 \) = Normality of silver nitrate  
\( V1 \) = Volume of silver nitrate (titer value)  
\( N2 \) = Normality of sample extract (unknown)  
\( V2 \) = Volume of sample extract taken
3.6.4 Trypsin Inhibitor Activity (Kakade, 1969)

**Principle:** The activity of the enzyme trypsin is assayed using casein as substrate. Inhibition of this activity is measured in the extract.

**Procedure:** 0.2 to 1.0 ml of aliquot, trypsin solution (0.05mg/ml in 0.001M HCl) were pipetted into separate triplicate set of test tubes and final volume adjusted to 1 ml and 2 ml with phosphate buffer (0.1M, pH 7.6) for aliquot and trypsin solution respectively. 1 ml of trypsin solution, added to aliquot tubes and all the tubes kept at water bath at 37°C. In one of the triplicate tubes of aliquot and trypsin solution, 6 ml of 5% TCA was added, marked as blank and in others, 2 ml of 2% casein solution added and then kept at 37°C for exactly 20 minutes. 6 ml of 5% TCA was added and absorbance was measured at 280nm after 1 hour against blank using a UV visible Elico spectrophotometer.

**Calculation:** Plot the absorbance against the volume of extract. One trypsin unit (TU) is defines as an increase of 0.01 absorbance units at 280nm in 20 minutes per 10 ml of the reaction mixture. Trypsin inhibitor activity is defined as the number of trypsin unit inhibited (TIU).

3.7 PRODUCT DEVELOPMENT

3.7.1 Selection of Recipes

A number of recipes were selected and prepared by using different varieties of kidney beans and their acceptability appraisals carried out. **In order to select recipes for the present study, various recipes were chosen from authentic books and magazines. Homemade recipes were selected, which could be fortified suitability to meet the objectives of the experimentation. The criteria for the selection of recipes depend on:-**

- Suitable for all age groups
- Easy availability of ingredients
- Ease in preparation
- Locally tinge
- Cost effectiveness
- Potential for optimum nutrition
- Capacity for health promotion
In order to select the recipes for the present study, various recipes were developed according to different age-groups; for infants, preschoolers, schoolers, adolescents, adults, elderly, pregnant women’s, lactating mothers. In addition, food products have been developed for some deficiency diseases-protein-energy malnutrition and other debilitating diseases- diabetes mellitus and coronary heart disease. Therefore, an effort was made to enrich the recipes by incorporating kidney bean varieties in raw and processed (hot-water blanching) form in different ratios (table 3.7.1.1). Based on these criteria different recipes were standardized for different life-stages and therapeutic conditions to make them more nutrient dense (appendix III). Six variants each of standard recipes were prepared with incorporation of varying proportion of raw and processed (hot-water blanching) kidney bean varieties respectively. They have been prepared in Food Science Laboratory, Banasthali University.

Table: 3.7.1.1 Recipes for life stages and therapeutic conditions with levels of incorporation

<table>
<thead>
<tr>
<th>Focused Group</th>
<th>Name of the Recipe</th>
<th>Level of Incorporation</th>
</tr>
</thead>
<tbody>
<tr>
<td>INFANTS</td>
<td>Wheat Rajmah premix</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Chivra Rajmah premix</td>
<td>10</td>
</tr>
<tr>
<td>PRESCHOOLERS</td>
<td>Blended boondi</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Rajmah-Rice toffee</td>
<td>20</td>
</tr>
<tr>
<td>SCHOOLERS</td>
<td>Nutri Sickle</td>
<td>20</td>
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<td></td>
<td>Cookies-en-Rajmah</td>
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<tr>
<td>ADOLESCENTS</td>
<td>Rom-Pom poli</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Nourishing Churma</td>
<td>20</td>
</tr>
<tr>
<td>ADULTS</td>
<td>Rajmah bati</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Raj-Rasam</td>
<td>15</td>
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<tr>
<td>ELDERLY</td>
<td>Bean-bade</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Smridh upma</td>
<td>20</td>
</tr>
<tr>
<td>PREGNANT WOMEN</td>
<td>Paustik Poha</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Augmented-poppadoms</td>
<td>10</td>
</tr>
<tr>
<td>LACTATING MOTHERS</td>
<td>Rustic papdi</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Enriched sev</td>
<td>50</td>
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<tr>
<td>GENERAL MALNUTRITION</td>
<td>Mix Veg.-bean khichdi</td>
<td>10</td>
</tr>
<tr>
<td>DIABETES MELLITUS</td>
<td>Rissi Missi Roti</td>
<td>10</td>
</tr>
<tr>
<td>CORONARY HEART DISEASE (CHD)</td>
<td>Double do Sag</td>
<td>20</td>
</tr>
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</table>
3.7.2 Development of Recipes in keeping with various life stages

3.7.2.1 Infants:

An infant or baby is the very young offspring of humans. Nutrient needs of infants reflect rates of growth, energy expended in activity, basal metabolic needs, and the interaction of the nutrients consumed. To meet the high nutritional requirement of an infant, Bal-ahar i.e. - *Wheat rajmah premix and Chivra rajmah premix*; were prepared. They are important source of proteins, vitamins and minerals and also add variety to the baby’s diet by providing new colors, textures, smells and tastes with good nutrition that aids in growth spurts. Thus following products have been developed with above considerations by incorporating kidney beans.

*Wheat Rajmah Premix*: It is a blend preparation of roasted ingredients and thus includes wheat flour, bengal gram dal and groundnuts. Sugar is also added for giving sweetness. It is highly energy dense and rich in protein content due to incorporation of kidney bean flour.

*Chivra Rajmah Premix*: It is soft, easily digestible and acceptable by infants. It requires less time and simple method of preparation. It can be consumed either in the powdered form or mixed with a little water, juice or milk.

3.7.2.2 Preschoolers:

Between 1 to 6 years, growth is generally slower than in the first year of life. Development of a full dentition by about the age of 2 years also increases the range of foods that can safely be eaten. For this purpose, it is required to develop the type of products which not only provide essential nutrients for their growth, but also build immunity to resist infections. Thus following products have been developed with above considerations by incorporating kidney beans.

*Blended Boondi*: It is small, round; crispy fried droplets made from chickpea flour. It is served with curd or eaten as that is. It is good source of calcium content. Incorporation of kidney beans increases the protein content which fulfills the nutrients demand during childhood.
Material and Methods

Rajmah-Rice Toffee: It is a popular snack of north India cuisine. It is also referred as rice flour fries and served as a handy food for preschoolers. It is based on cereal-pulse combination so would be improved the amino acid profile.

3.7.2.3 Schoolers:

Children require some nutrients such as calcium, iron and protein which play a vital role in growth and development and also fulfill the bodily requirements. Calcium is needed for adequate mineralization and maintenance of growing bone in children and iron is also important for prevention and cure from high risk iron deficiency anemia in adolescence. Likewise, protein is needed for tissue replacement and growth. They need more nutritious food in proportion to their size than do adults. Incorporation of kidney beans increases the nutritive value of developed recipes such as Nutri-sickle and Cookies-en-rajmah. Thus following products have been developed with above considerations by incorporating kidney beans.

Nutri-Sickle: It is made from chickpea flour. Carom seeds and salt is added for additional flavor and taste. It is nutritious snack item and fulfills the energy and protein requirements of school-going children’s.

Cookies-En-Rajmah: Cookies are made from refined wheat flour. They are consumed all around the world and mostly liked by children’s. Coconut powder and cardamom powder are also added for good flavor. They are highly energy dense and rich source of carbohydrates. To improve nutritive value of cookies, kidney beans were incorporated to enhance protein, calcium and iron content.

3.7.2.4 Adolescents:

The physical and mental human development generally occurs between puberty and adulthood. During this important time, there a high incidence of nutritional deficiencies and poor eating habits. Iron requirements are high during adolescence because of growth and some physiological changes. Some recipes such as Rom-pom poli; Nourishing churma is highly nutritious and helpful in attaining
good health. Thus following products have been developed with above considerations by incorporating kidney beans.

**Rom-Pom Poli:** It is a traditional type of sweet flatbread which is commonly consumed in Maharashtra. It is equally delicious and served as a breakfast dish or mid-afternoon snack. It is highly nutritious and energy dense recipe. Jaggery is used in the recipe which increases the iron content. Incorporation of kidney beans increases its protein content and also improves the quality of protein.

**Nourishing Churma:** It is traditional energy rich Rajasthani delicacy usually served with baatis and dal. It is made from wheat flour, khoya and ghee. It is usually rich in calories. Efforts are made to enrich its protein quality by incorporating kidney beans in flour form.

### 3.7.2.5 Adults:

Adults need good nutrition to help keep adult people strong their need for energy is satisfied for their active lives that may involve athletic pursuits and busy days filled with work and raising children. Therefore, adequate amounts of all the essential nutrients need to be provided to adults through their diets for maintaining both physical and mental health and reducing risk of debilitating diseases. Such recipes- *Rajmah bati; Raj-rasam* etc. provide optimum nutrition in adulthood to ensure good health. The following products have been developed with above considerations by incorporating kidney beans.

**Rajmah-Bati:** Bati is hard, unleavened bread cooked in the dessert areas of Rajasthan and Gujarat. It is made from whole wheat flour and added small amount of chickpea flour. It has long shelf life. Incorporation of kidney beans increases the protein content and other required nutrients.

**Raj-Rasam:** Rasam is a soupy dish that originates from South Indians. Curry leaves and tomatoes are used to increase the vitamin A and C and with the incorporation of kidney beans protein quality also enhanced.

### 3.7.2.6 Elderly:
Old age (also referred to as elderly) consists of people with age around or surpassing the average life span of human beings. As people reach their mature years, nutrition becomes critical, as many people in their later years fail to eat properly due to medical conditions and medications or social factors. A healthy eating plan for older adults includes a variety of nutrient-rich foods encouraged whole, unprocessed foods that are high in calories and other nutrients. Some examples include: **Smridh upma; Bean-bade;** are healthy recipes based on whole grain cereals, protein-rich beans, legumes and dairy products and healthy fats. This will help ensure that they are getting all the vitamins and minerals needed to maintain proper health. Thus following products have been developed with above considerations by incorporating kidney beans.

**Smridh Upma:** Upma is a vegetarian dish usually made with semolina or rava which is coarse, purified wheat middlings. It is tempered with mustard seeds, curry leaves, green chillies and ginger. Other ingredients - onions, chillies, and tomatoes often added to it and cooked to a porridge-like consistency. It is the classic couscous-like South Indian popular hot cereal breakfast.

**Bean-Bade:** It is a popular North Indian street food fare and a mouth-watering recipe. It is made with dahi, urad dal with a combination of tamarind chutney. Incorporation of kidney beans increases the protein and calcium content.

### 3.7.2.7 Pregnant Women:

Pregnancy is the carrying of one or more offspring, known as a fetus or embryo, inside the womb of a female. Pregnancy is a good time will need to pay particular attention to nutrition. Women have higher protein, iron and calcium requirements, so more of protein, iron and calcium rich foods based on whole cereals, pulses with husk, green leafy vegetables and dairy products need to be provided in their diets. Some recipes include - **Paustik poha; Augmented-poppadoms** which provide adequate amount foods items so as to fulfill nutritional requirements of fetus plus mother. Thus following products have been developed with above considerations by incorporating kidney beans.
**Material and Methods**

**Paustik Poha:** It is easy-to-cook and a very delicious nutritious snack of Indian cuisine. It is often eaten in breakfast or brunch. Basically made from rice flakes which are highly rich in iron and incorporation of kidney beans increases the protein content.

**Augmented-Poppadoms:** It is energy dense snack. However, while preparing *poppadoms* the incorporation of kidney beans increases its protein, calcium and phosphorus content which would be helpful to fulfill the extra requirements of nutrients.

3.7.2.8 Lactating Mothers:

Nutritional demand on the mother is even greater during lactation. Dietary practices and food choices are related to wellness and affect health. Foods that are chosen to provide the energy must be highly nutritious, containing high amounts of essential nutrients such as vitamins, minerals and essential proteins. Diet based on cereals- whole grains and protein rich foods- legumes, beans or pulses, milk and milk products, nuts, and cereal and pulse combinations and vegetables. Some recipes include- Rustic papdi; Enriched sev etc. which provides optimum nutrition to fulfill the requirements of lactating mothers. Thus following products have been developed with above considerations by incorporating kidney beans.

**Rustic Papdi:** It is basically made from refined wheat flour and semolina. Til was used which had galactogenic effect which helps to increase the milk production and kidney beans to enrich its protein quality.

**Enriched Sev:** It is usually made from chickpea flour. It is a snack item taken mostly with tea. Incorporation of kidney beans increases the protein and calcium content of sev.

3.7.3 Development of Recipes in keeping with Therapeutic and Health Augmentation Approach-

Two types of disorders have been dealt with, to make the food products.

3.7.3.1 General Malnutrition

3.7.3.2 Diabetes Mellitus and Coronary Heart Disease (CHD)
3.7.3.1 General Malnutrition:

Nutritional deficiency is that diseases which are directly or indirectly caused by a lack of essential nutrients in the diet. Nutritional diseases are commonly associated with chronic malnutrition. Inadequate intake of diet can cause nutrient deficiencies in body. Protein-energy malnutrition-kwashiorkor and marasmus is one of the serious health problems which are commonly seen in vulnerable group of society. The diet prescribed should be rich in protein and calories with other nutrients. Kidney beans could be beneficial to provide essential nutrients. The following recipe is developed by incorporating kidney beans.

*Mix-Veg.-Bean Khichdi:* It is based on traditional cereal-pulse combination with the addition of variety of vegetables to make it highly nutritious. This is made from rice and washed green gram dal. Addition of vegetables- bottle gourd, spinach, potato, onion and tomato gives the khichdi great flavor, make more tasty and nutritious. It is easy to digest and a very healthy balanced food with full of nutrients (energy, protein, iron and vitamins) and wholesome meal especially for infants and kids those suffering from protein-energy malnutrition. Thus regular intake of this recipe will help in overcoming the deficiency.

3.7.3.3 Diabetes Mellitus and Coronary Heart Disease (CHD)

*Diabetes Mellitus*

Diabetes is a serious metabolic disorder. Regular intake of kidney beans flour incorporated with other flours will help to regulate the blood sugar level. Thus following recipe is developed by incorporating kidney beans.

*Rissi Missi Roti:* Missi roti is unleavened flat bread basically made from whole grain wheat and legume (chickpea) in flour form. Spinach is also added to make the roti more nutritious and high in iron content. It is an excellent way of sprucing up the proteins in diet for diabetics because of kidney beans flour added to it as an ingredient so that the recipe becomes low glycemic.

*Coronary Heart Disease (CHD)*

Coronary heart disease is a major life-threatening disease. Regular intake of kidney beans incorporated with other pulses could be helpful to regulate the cholesterol level in blood. Thus following recipe is developed by incorporating kidney beans.
**Double Do Sag:** Dal Sag or Dal Palak is made from washed green gram dal with spinach added in chopped form. It is a good source of protein and spinach in highly rich in iron and fiber. Beans nutritious, moderate energy and hypocholesterolemic, it can prove a healthier dish for cardiac patients in the long run. It is served with chapatis, parathas or rice makes a nutritionally complete meal.

### 3.8 SENSORY EVALUATION

Sensory evaluation is considered to be an important analytical tool in the present day competitive environment to judge the acceptability of food among the potential consumers. A panel is an analytical tool in sensory evaluation. Interest, motivation, general attitude and emotional state of the panelist may be responsible for reliable and valid judgment. The value of food depends on the objectivity precision and reproductively of the judgment of the panelists. The people who serve as panelists should be in good health and should absent themselves when suffering from conditions that might interfere with normal functions of taste and smell (Jellinek, 1985). Therefore, the panelists were made to feel that they were doing an important activity and that their contribution was very important. The panelists were given an explanation about the sensory attributes; they were supposed to measure, so the test subjects should meet the following conditions.

- **Sensitivity** – Panel member should have normal olfactory and gustatory sensitivity which can be improved by training.
- **Age** – All interested persons regardless of their age were admitted.
- **Avoidance of disturbance during a test** – Sensory analysis requires intense concentration by the panel members. Therefore, disturbance such as noise, off odors etc. must be avoided. In addition, test subjects should not have the chance to influence each other by facial expression or orally conveyed results.
- **Additional points to be taken into consideration** – The panel members should rinse their mouth properly before starting the test.

#### 3.8.1 Selection of Semi-Trained Panel Members

Selection of panel members involved the screening of 30 post graduate students of Home Science faculty who were apparently healthy, with no habit of
smoking and tobacco chewing and also had some basic information about sensory testing. The final selection was made through **triangle difference test performed as under:**

This test was named so because it involves the presentation of three samples to the panel members in a triangular form but in practice they are kept in a straight line. In the present study, triangle difference test was conducted using tea. Among the three samples, two were alike and one was different. The panel members were asked to pick out in each triangle set the sample which is different.

- In this, three cups of tea were prepared.
- Out of the three, two had same percentage of sugar and one, a lower percentage.
- These were coded as A, B, C and randomly presented to the testers.
- The panel members were asked to pick out in each triangle set the odd sample of tea.

A well prepared questionnaire (Appendix-IV) for triangle test was provided to the students. After the evaluation, the performa was collected from each member and evaluation was done on the basis of discrimination ability, to select panel members, for carrying out the analysis of the various food products developed by incorporating kidney bean varieties.

Fifteen students could discriminate the odd sample correctly along with identification of the right reason of difference, having sharp discrimination, discretion and communication powers were selected to constitute the semi-trained panel of judges. They were then given the required instructions regarding conduction of sensory evaluation.

### 3.8.2 Sensory Evaluation Using Hedonic Scale

Evaluation of sensory characteristics of nineteen standardized recipes prepared by using different varieties of kidney beans was done by selecting fifteen semi-trained panel members after giving detailed instructions regarding the method of scoring. The evaluation was done using:
Material and Methods

- **Nine Point Hedonic Rating Test**
  In this test, the panelists were asked to measure the degree of pleasurable and unpleasurable experience of the food products on a nine point hedonic rating scale ranging from “like extremely” to “dislike extremely”. The former carried a score of 9 while latter was scored as 1. Performa has been attached in appendix-V.

- **Ranking Test**
  The ranking method rapidly allows the testing of several samples at once. After selecting the best variant from each product using 9 point hedonic test, ranking was done on the basis of mean score (all attributes) of best acceptable variant of all recipes, the one scoring. The highest was ranked first and subsequently followed by other variants.

**Points to be Considered While Conducting Sensory Test**
Sensory evaluation was conducted in a laboratory, free from noise and odor between 10-11 a.m; as members felt free during this time. Each sample was introduced separately to each of the panel member and water was provided after tasting of each sample to remove any effect of after taste.

- The samples were homogenous and temperature was standardized to keep constant before conducting test.
- It was a quiet area, free from any disturbance.
- Natural light source was used during the test as it would not influence the appearance of the product to be tested.
- Judges suffering from cold or ill health were not allowed to evaluate.
- Use of odoriferous substance (cosmetics) was avoided.
- No communication between panelists was allowed so that they could make their independent judgement.

**3.9 STATISTICAL ANALYSIS**
Statistics is the science of collection, organization, presentation, analysis and interpretation of numerical data. The large volume of numerical information gave rise to the need for systematic methods which can be used to organize, present, analyze and interpret the information effectively.
One of the most important objectives of statistical analysis is to get one single value that describes the characteristic of the entire mass of unwind data. Such a value is called “Central value” or an “Average” or the expected value of the variable.

The statistical methods using for analysis of data in the present investigation were:

- Mean
- Student’s t-Test
- Standard Deviation
- Diagrammatic representation

### 3.9.1 Mean (X) (Gupta, 2004)

The arithmetic mean is the "standard" average of a set of values, or distribution or often simply called the mean, of two numbers. For a data set, the mean is the sum of the values divided by the number of values. It is perhaps the familiar, most frequently used statistics. **The following formula was used for calculation of mean for graded data.**

**Calculation:**

\[
X = \frac{\sum X}{N}
\]

Where, \(X = \text{Mean} \); \(X = \text{Value of variable} \); \(N = \text{Total number of observations} \);
\(\sum = \text{Summation} \)

### 3.9.2 Standard Deviation (\(\sigma\)) (Steel and Torrie, 1980)

It is the square root of the mean of the squared deviations from the arithmetic mean. It is conventionally represented by Greek letter sigma (\(\sigma\)). It is a widely used measure of variability or diversity used in statistics and probability theory. It shows how much variation or "dispersion" exists from the average (mean, or expected value). The standard deviation (\(\sigma\)) is the square root of the variance of \(X\), i.e., it is the square root of the average value of \((X - \mu)^2\).

**Calculation:**

\[
\sigma = \sqrt{\frac{\sum d^2}{N}}
\]

Where, \(\sigma = \text{Standard deviation} \); \(\sum d^2 = \text{Sum of sequence of deviation measured from arithmetic mean} \); \(N = \text{Total no. of samples} \)
3.9.3 Student’s t-Test (Steel and Torrie, 1980)

T-distribution is commonly called student’s t-distribution or simply student’s distribution. Hypothesis was tested at 95 confidence level. For this student’s t was applied. It is generally used to test the significance of various results obtained from small samples (n<30). Student’s t test procedure was used to make inference about the difference between two groups.

Calculation:

\[ t = \frac{X_1 - X_2}{S} \times \sqrt{\frac{n_1 + n_2}{n_1 n_2}} \]

Where, \( X_1 \) = Mean of first sample; \( X_2 \) = Mean of second sample; \( n_1 \) = Number of observations in first sample; \( n_2 \) = Number of observations in second sample; \( S \) = Combined standard deviation

\( P<0.05 \) = Significance difference, \( P>0.05 \) = Non-significance difference

3.9.4 Diagrammatic representation (Gupta, 2004)

Visual presentation is widely used and is more effective than tabular or verbal description. Due to these, graphs were made out of data for the interpretation of the findings in the present study. Bar diagram were preferred because of simplicity, clarity, accuracy and easily readability.