Formulation of rice bean (*Vigna umbellata*) based geriatric premix

Dissertation II Report

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CERTIFICATE

This is to that **Damanpreet Kaur** (Registration No. 11713979) has personally completed M.Sc. dissertation II entitled "**Formulation of rice bean (*Vigna umbellata*) based geriatric premix"** under my guidance and supervision. To the best of my knowledge, the present work is the result of her original investigation and study. No part of dissertation has ever been submitted for any other purpose at any University.

The project report is appropriate for the submission and the partial fulfillment of the conditions for the evaluation leading to the award of Master of Nutrition and Dietetics.

Date: 11th May, 2018

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Chapter 1: Introduction

Older population is the largest group which is at high risk of nutritional deficiency in the society. Geriatrics is the study of aging process that focuses on the health of elderly people. The word Geriatrics is derives from the Greek word geron meaning 'old man' and iatros meaning 'healer'. According to Food and Nutrition Guidelines for Healthy Older People the older population is defined as those aged 65 years and older. The process of aging is often associated with various physical, psychological, cognitive, social and lifestyle changes that influence the dietary intake and nutritional status of the elderly people. Nutrition deserves special attention as an individual reaches old age as it is essential for maintaining the good health of the old population. The application of nutrition for the management of physical, psychological and physiological changes that are associated with aging is termed as geriatric nutrition. The older population shows decline in physiological function that influences their nutritional status, including sarcopenia, xerostomia or dry mouth, changes to gastrointestinal tract, sensory changes, changes in food intake and anorexia of aging.

Beans are known to play an important nutritional role especially in developing countries like India with low socioeconomic group. Beans are the cheap and best source of quality proteins, dietary fibre, minerals, vitamins, slow digestible starch and bioactive phytochemical which aid in reducing the risk of several chronic and metabolic diseases (Bepary et al. 2016).

Rice bean (*Vigna umbellata*) is a multipurpose legume crop belonging to *Vigna* species. It is an 'under-utilized' or 'orphan' crop which is native to Indo-China. Rice bean is easily established on exhausted soil and has a good nitrogen fixing capacity. It restores soil fertility and is relatively resistance to draught, pest and diseases. In some places, Rice bean has a reputation of "poor man's food"(Andersen 2012).

Studies have shown that rice bean contain carbohydrates (54.21-60.49%), proteins (15.64-21.60%), crude fibre (5.53-6.56%), fat (1.22-2.3%) and ash (3.34-3.8%) (Bepary et al. 2016). The in-vitro protein digestibility of rice bean as evaluated by Katoch (2013), Kalidass and Mohan (2012) and Awasthi et al. (2011) was fond to be 51.23-55.57%, 72.4% and 83.3-88.5% respectively. It also has higher content of essential fatty acid i.e. linoleic acid as compared to green gram and black gram (Bepary et al. 2016).

Though pulses are usually deficient in methionine and tryptophan, rice bean is known to contain both the acids with methionine content of 1.78±0.72 g/100g of protein and tryptophan content of 1.34±0.38 g/100g of protein (Beapry et al. 2016).

Rice bean has low level of glycemic index , tannin, oligosaccharide and high protein, calcium and zinc bioavailability and is good source of minerals like calcium, iron, zinc, potassium, manganese and copper (Andersen 2012; Bepary et al. 2016).

Chickpea (*Cicer arietinum* L.) also called garbanzo bean or Bengal gram is an old-world pulse belonging to family Fabaceae and is consumed worldwide, especially in Afro-Asian countries(Jukanti et al. 2012 ; Rachwat et al. 2013). It is cultivated extensively throughout the world including East Africa, South and North America, Central and South Asia, Mediterranean basin and Australia with India being the leading manufacturer contributing about 66% of the global produce (Rachwat et al. 2013; Segev et al. 2012).

Based on the variation in size, shape and color, chickpea is classified into two categories:

kabuli type- having thin seed coat varying in color from white to cream and

desi type- having thicker, irregular shaped seed coat varying in color from light tan to black (Segev et al. 2012).

Chickpea is considered as cheap and best source of healthy vegetarian diet containing high quality proteins, fats, dietary fibre, vitamins and both macrominerals like calcium, potassium, sodium and magnesium and microminerals like copper, iron and zinc. Chickpea flour is known to have low glycemic index and low carbohydrate availability (Rachwat et al. 2013).

Studies have shown that the energy provided by desi variety grains is 327 kcal/100g and that provided by kabuli variety grains is 365 kcal/100g (Maheri-Sis et al., 2008). It was also seen that chickpea protein digestibility varies between 48-89.01% (Rachwat et al. 2013).

The consumption of beans is often limited due to the presence of several anti-nutritional factors(ANF) like phytic acids, tannins, saponins, trypsin inhibitors etc.. The presence of these anti-nutritional factors reduces the bioavailability of nutrients present in them and decreases the protein digestibility and starch digestibility. However, treatments like cooking, soaking, germination and roasting prove beneficial in reducing the ANF and hence increase the consumption of beans.

In the present study an attempt has been made to develop a ready to eat geriatric premix using underutilized pulse viz. rice bean and other valuable ingredients. The study also aims to study the antinutrient reduction potential of various processing methods on rice bean.

Chapter 2: Problem background

Elderly people face numerous problems such as sarcopenia, xerostomia or dry mouth, changes to GI tract, sensory changes, changes in food intake and anorexia of aging. Most of these are a result of nutritional deficiency and these anomalies needs to be taken care of in order to maintain their health and wellbeing. There is a lack of proper nutritional guidelines or a commercial product for geriatric population. Hence, the present study attempts to develop a premix product based on underutilized pulses to deliver adequate nutrients to the aging population of the world.

Chapter 3: Review of Literature

3.1 Problems of elderly people

Older population is the largest group which is at high risk of nutritional deficiency in the society. According to Food and Nutrition Guidelines for Healthy Older People the older population is defined as those aged 65 years and older. The process of aging is often associated with various physical, psychological, cognitive, social and lifestyle changes that influence the dietary intake and nutritional status of the elderly people. Nutrition deserves special attention as an individual reaches old age as it is essential for maintaining the good health of the old population. The older population shows decline in physiological function that influences their nutritional status, including sarcopenia, xerostomia or dry mouth, changes to gastrointestinal tract, sensory changes, changes in food intake and anorexia of aging.

3.1.1 Sarcopenia

The decline in the lean body mass with the advancing age is referred to as sarcopenia and is one of the major age-related physiological change in older population. This declined skeletal muscle mass is associated with decreased protein reserve, loss of strength and reduction in performance. Inadequate dietary protein or impaired protein utilization is known to indirectly contribute to progression of sarcopenia.(Brownie 2006)

3.1.2 Xerostomia or Dry Mouth

About 50% of the older population is affected by xerostomia or dry mouth. The use of hundreds of medications and hyposalivation or reduced saliva flow or inadequate fluid intake is known to produce dry mouth in older people. People with xerostomia have difficulty in chewing and swallowing, dryness in mouth, oral ulcerations and impaired tasting (Ho et al. 2017).

3.1.3 Changes in gastrointestinal tract

The process of ageing is associated with diminished gastrointestinal tract efficiency that affects the nutrient ingestion, absorption, metabolism and elimination. The diminished GI tract efficiency is mainly due to Atrophic gastritis and Oral changes (Brownie 2006).

Atrophic gastritis

Atrophic gastritis affect about 20-50% of older population (Brownie 2006). Atrophic gastritis or the atrophy of stomach mucosa results in reduced secretions of intrinsic factor, gastric acid and pepsin from the stomach (Ministry of Health 2013). This reduces the bioavailability of folic acid, vitamin B_{12}, iron, calcium and beta carotene in old people as the absorption of these nutrients is pH dependent and is adversely affected by low acid in stomach (Brownie 2006).

Oral changes

The ability of older people to chew or swallow food is largely affected by changes in oral cavity such as loss of teeth or ill-fitting dentures and reduced saliva production. This may be associated with the decreased consumption of food that is difficult to chew such as some vegetables, fruits and nuts and some meats. According to Food and Nutrition Guidelines for Healthy Older People, the oral health of elderly people can decrease the absorption of micronutrients including vitamin C, vitamin E, vitamin B_{12} and fibre. About 39-45% of elderly people have restored to texture modified diet in order to reduce the irritation and buccal pain caused by chewing of regular food items (Brownie 2006).

3.1.4 Sensory changes

Old age is associated with alterations in chemosensory perception and reduction in the ability to detect one or more of the four basic taste including sweet, sour, salty and bitter. The sensory changes may affect the nutrient intake and may cause the difficulty in distinguishing between spoiled and fresh food (Ministry of Health 2013).

3.1.5 Changes in food intake

The physiological decline in food intake is very common among old population and is associated with changes in gut peptide hormones, early satiety, reduced stomach capacity and slow gastric emptying. Changes in dentition, impaired taste and smell can also result in decline food intake (Ministry of Health 2013).

3.1.6 Anorexia of Aging

The major physiological change among aging population is anorexia of aging which is defined as “physiological age-related reduction in food intake”. Reduced appetite, decreased hunger, early satiation and reduction in energy expenditure due to reduced physical activity all contribute to anorexia of aging (Soenen et al 2013).

3.2 RDA for elderly people

The recommended dietary allowances for people aged 65 years or above as suggested by ICMR is:

Group	Male			Female		
Particular	Sedentary	Moderate	Heavy	Sedentary	Moderate	Heavy
Energy (kcal/d)	1768	2622	3450	1624	2204	2900
Protein (g/d)	46	50	45	45	40	45
Carbohydrates (g/d)	265	393	517	243	330	435
Visible fats(g/d)	30	43	57	27	36	48
Calcium (mg/d)	800-1200	800-1200	800-1200	800-1200	800-1200	800-1200
Iron (mg/d)	17	17	17	17	17	17
Vitamin A(µg/d)	600-700	600-700	600-700	600-700	600-700	600-700
Riboflavin (mg/d)	1.3	1.3	1.3	1.1	1.1	1.1
Ascorbic acid(mg/d)	45	45	50	45	45	45
Dietary folate(µg/d)	400	400	400	400	400	400
Vitamin B_{12}(µg/d)	2.5	2.5	2.5	2.5	2.5	2.5
Zinc(mg/d)	7.0	7.0	7.0	4.9	4.9	4.9
Vitamin D (µg/d)	1015	1015	1015	1015	1015	1015
Vitamin E (IU/d)	100-400	100-400	100-400	100-400	100-400	100-400
Selenium (µg/d)	50-70	50-70	50-70	50-70	50-70	50-70

3.3 Rice Bean (*Vigna Umbellata*)

Rice bean (Ohwi and Ohashi) is underutilized crop belonging to family *Vigna* and is the native of South-East Asia. In India, it is mainly distributed in Eastern and Western Ghats, North-Eastern hills and some parts of Himachal Pradesh (Awasthi et al. 2011). In India, Rice Bean is known by variety of names as Rajmoong, Satrangi, Navrangi, Moth, Haramah and Paharimah (Himachal Pradesh), Bete (Mizoram), Chak hawai (Manipur), Bejiamah(Assam), and Jami and Agukzungken (Nagaland) (Andersen 2012). Rice bean finds its use in the preparation of whole dhal, deep fried snacks, thick soups and component of festival dishes as kwati and khichadi (Bepary et al. 2016)(Gualda 2013). Rice bean is known to possess high nutritional potential with high protein content, essential amino acids, vitamins, minerals (Ca, Fe, Zn, Cu and Mn) and low fat content which helps to supplement cereal diets. But the use of rice bean in routine is limited despite its high nutritional profile due to the presence of non-nutritional factors like phenolic compounds as tannins, saponins, enzyme inhibitors, oligosaccharides, biogenic amines and allergens (Katoch 2013). The health potential of Rice bean is also studied by several scientists.

3.3.1 Nutritional composition of Rice Bean

Rice beans are considered to be rich source of quality proteins, carbohydrates, vitamins, minerals and essential amino acids. Nutritional composition of rice bean is presented in the table

Components	
Proteins	20.62±3.18 %
Amino acid profile(g/100g of protein)	
Lysine	11.88±1.36
Histidine	3.06±1.05
Aspartic acid	7.45±0.96
Methionine	1.78±0.72
Tryptophan	1.34±0.38
Fat and fatty acid profile	
Crude fat	1.74±1.42%
Linolenic acid	34.17±13.28%,
Lioleic acid	19.92±03.28%
Oleic acid	15.58±2.24%
Carbohydrates profile	
Carbohydrates	52.23-68.5 %
Starch	46.42-55.1%
Soluble sugar	3.5-5.6%
Raffinose	0.3% -2.58%
Stachyose	0.37% -1.98%
Verbascose	0.45% -2.58%
Dietary fibre	21.5%
Minerals	
Calcium(mg)	490.98±85.60
Magnesium(mg)	337.65±20.67

Iron(mg)	8.38±0.88
Phosphorous(mg)	505.41±95.49
Sodium(mg)	310.04±23.95
Zinc(mg)	2.99±0.33
Potassium(mg)	1605.80±64.14
Vitamins	
Vitamin A(IU)	21
Vitamin E(mg)	0.08
Vitamin C(mg)	1.4
Thiamine(mg)	0.49
Niacin(mg)	2.88
Riboflavin(mg)	0.31
Pyridoxine(mg)	0.14
Folate(µg)	131

(Bepary et al. 2016)

3.3.2 Anti -nutritional factors in Rice bean

The consumption of Rice beans despite its high nutritional potential is limited due to the presence of several anti-nutritional factors like:

Anti-nutrient factors	
Phytic acid(mg/100g)	205.38±27-432.14±57
Tannin(mg TAE/100g)	893.04±11-1090.06±20
Saponins(mg/100g)	690.7±08-1753.7±17
Trypsin inhibitors(TIU/g)	47.37±4.11-140.34±3.89

(Bepary et al. 2016)

Phytic acid

Phytic acid act as chelators and binds with Zinc, Calcium and Iron and forms insoluble compound with them and reduces their bioavailability and it also reduces the bioavailability of starch and proteins (Bepary et al. 2016).

Tannins

Tannins decreases the nutritional quality of food by decreasing the bioavailability of vitamin B_{12} and minerals like calcium, iron and zinc and forms complexes with proteins, starch and digestive enzymes and decreases their digestion(Bepary et al. 2016)

Saponins

Saponins are known to reduce nutrient absorption and affects protein absorption by reducing the activity of enzymes- chymotrypsin and trypsin (Bepary et al. 2016).

Trypsin inhibitors

Trysin inhibitors decrease the activity of protein digesting enzymes and hence decrease the absorption of protein in the body (Bepary et al. 2016).

3.3.3 Health potential of Rice Bean

Rice bean is known to be important source of dietary antioxidants which include ascorbic acid, α-tochopherol, amino acids, peptides, phenolic compounds, carotenoids, flavonoids and proteins (Bepary et al. 2016). The antioxidant possesses free radical scavenging activity and reduces the oxidative stress of cells of diabetic patients and treats diabetes (Yao et al. 2012). Studies have shown that rice bean possess anti-diabetic, anti-inflammatory, anti-fungal, anti-hypertension and anti-cancer properties. It also boosts immune system and is known to treat jaundice, rheumatic arthritis, edema, sores, boils and appendicitis in South East Asia (Bepary et al. 2016).

Components	
Total phenolic content(GAE/g)	3.27 ± 0.04-6.43 ± 0.25
Total flavonoid content(µg CE/g)	55.95 ± 11.16-294.52 ± 22.05

(Yao et al. 2012)

3.4 Chickpea (*Cicer arietinum* L.)

Chickpea is one of the oldest and widely consumed annual grain legume which is cultivated throughout the world including Central and South Asia, Mediterranean basin, East Africa , Near East, Australia and North and South America (Segev at al. 2012). It is the third most largest grown food legume in the world after common bean (Phaseolus vulgaris L.) and pea (Pisum sativum L.) (Xu et al. 2014). Based on the variations in shape, size and color, chickpea is divided into two categories: kabuli-type(thin seed coat with color ranging from white to cream) and desi-type(thick, irregular seed coat with color ranging from light tan to black) (Segev et al. 2012). It is cheap and best source of carbohydrates, proteins, dietary fibre, vitamins and minerals. The consumption of chickpea is done only after cooking, roasting, baking and frying so as to reduce anti-nutritional factors present in them. In India, the flour of chickpea called ‘besan’ is used in snack preparation and in the other parts of the world, it is used in stews, soups and salads (Jukanti et al. 2012). It is also known to possess various health benefits.

3.4.1 Chemical composition of Chickpea

The chickpea is a good source of quality proteins, fats, dietary fibre, minerals and vitamins but it contains low carbohydrate content. The chemical composition of chickpea is given in the table

Component	Varieties of chickpea (%)	
	Kabuli	Desi
Dry matter	92.08	91.17
Crude protein	24.63	22.76
Crude fibre	6.49	9.94
Total tannin	0.09	0.12
Total phenolic compounds	0.27	0.26
Non fibrous carbohydrate	49.13	46.81
Starch	39.12	38.48
Soluble sugars	8.43	7.53

(Rachwat et al. 2013)

Components	Chickpea (kabuli)	Chickpea (desi)
Vitamins(mg/100g)		
Folic acid	299.0	206.5
Vitamin C	1.34	1.65
Vitamin B_1	0.49	0.29
Vitamin B_2	0.26	0.21
Vitamin B_3	1.22	1.72
Vitamin B_5	1.02	1.09
Vitamin B_6	0.38	0.30
Vitamin E	12.9	11.2

(Jukanti et al. 2012)

3.4.2 Antinutritional factors in chickpea

The presence of anti-nutritional factors limits the biological value and use of chickpea in food. The presence of anti-nutrients interferes with the digestion and limits the availability of other nutrients present in them. The anti-nutrients commonly present in chickpea are listed in table

Anti-nutrients		References
Tannins (mg/g)	4.85	Alajaji et al. 2006
Phytic acids (g/kg)	10.6	Wang et al. 2010
Trypsin inhibitors (mg/g dm)	8.29	Wang et al. 2010
Saponins (g/kg)	56	Jukanti et al. 2012

Trypsin inhibitors

The presence of trypsin inhibitors interferes with the activity of protein digesting enzymes and reduces the protein absorption in human body (Rachwat et al. 2013)

Phytic acids

Phytic acids are known to decrease the bioavailability of minerals like calcium, iron and zinc in the body by forming the soluble complexes with them (Rachwat et al. 2013). The phytic acid content(4.9-6.1 mg/g) of chickpea is found to be less than kidney bean (11-17mg/g), fava bean (10.1-13.7mg/g), and soybean (10-14.7mg/g) (Thavarajah et al. 2012).

Tannins

Tannins are known to inhibit enzyme activity, decrease the digestion and make chickpea astringent (Jukanti et al. 2012).

Saponins

Chickpea is known to contain higher saponin content (56g/kg) than other pulses such as green gram(16g/kg), lentils(3·7–4·6g/kg), faba bean (4·3g/kg) and broad bean (3·5g/kg) and is responsible for giving bitter taste to pulse (Jukanti et al. 2012).

3.4.2 Health potential of chickpea

Chickpea is considered as a functional food with a potential of optimizing health and reducing several chronic diseases. The antioxidant properties of chickpea due to phenolic compounds are known to reduce the oxidative stress in humans and the presence of bioactive compounds like isoflavones is known to have oestrogenic, antifungal, antibacterial and antioxidant properties (Rachwat et al. 2014). The presence of essential fatty acid that is linoleic acid produce the hormone- like prostaglandis which lowers the blood pressure. On the medical side, chickpea is used as tonic, stimulant, appetizer, and in the treatment of bronchitis. It is also used to alleviate thirst and as a hypocholesteremic agent (Zia-Ul-Haq et al. 2007). Chickpea also aid in weight reduction due to low glycemic index value. Studies have revealed that chickpea increases the bowel health and relives constipation. Chickpea is also effective in the control of cholesterol, diabetes and blood pressure (Jukanti et al. 2012).

3.5 Removal of antinutrients

Both rice bean and chickpea are known to contain anti-nutrients which limit their consumption in diet despite having high health potential. Several processing methods are adopted to reduce or eliminate the anti-nutrients present in the beans. These include soaking, germination, cooking and roasting. There is significant reduction in the amount of anti-nutrients when these processing techniques are conducted at variable time and temperature.

3.6 Physico-chemical properties of powdered foods

Food powders represent diverse group of food products that can be distinguished not only by their composition and microstructure but also by the particle size, size distribution, chemical and physical properties. The properties of food powders are affected by equipments, pre-treatments, processing conditions etc.

Bulk density

It is defined as the mass of particle that occupies unit volume of bed. The factors that influence the bulk density of food powders include particle density, air density, porosity etc. (Canovas et al. 2005).

Dispersibility

Dispersibility is the property of food powders of getting wet without the formation of lumps in water. Dispersibility of powder will increase by decreasing the additives (Jaya et al. 2004).

Flowability

Flowability of food powders is defined as the ease with which the powder particle move with respect to each another and it measures the flow characteristic of powder. High fat content powder possess low flowability as compared to powder with low fat content(Sharma et al. 2012)

Foaming properties

Foaming property is the capacity of proteins to form interfacial film to keep air bubbles in suspension and slows the rate of coalescence. The foaming properties mainly depend upon proteins, pH and other components like carbohydrates present in the flour (Sreerama et al. 2012).

Emulsifying properties

The emulsifying property is the ability of proteins to aid in emulsion formation. It reflects the ability of proteins to absorb the interfacial area of oil and water in emulsion and hence impart strength to an emulsion(Du et al. 2013)

Wettability

Wettability is the potential of powder to absorb water on the surface and get wetted and penetrate the surface of still water. Lower the contact angle, greater the wettability. Wetting of powdered foods is affected by particle size, pore size, surface charge, density, surface area and the surface activity of particle (Sharma et al. 2012)

Compressibility

Non cohesive powders occupy more volume in container as compared to cohesive powder. Cohesive powders have high compressibility as they produces open structure supported by interparticle forces which collapse readily when low pressure is applied (Micha 2001)

Water holding capacity

It is defined as the amount of water held between the spaces of powder particle and the thin film surrounding the particle. It depends upon the cohesiveness of food powder.

Insolubility index

It is the indirect method to measure the solubility of powder and indicate the degree of denaturation of proteins. It is affected by particle temperature, pH or added salts (Pugliese et al. 2017).

Chapter 4: PROPOSED RESEARCH OBJECTIVE

1. To perform the quantitative and qualitative analysis of antinutrients factors in rice bean
2. To prepare ready to eat premix for elderly people using rice bean
3. To study the shelf life of the developed geriatric premix.

Chapter 5: PROPOSED RESEARCH METHODOLOGY

5.1 Detailed plan work

5.1.1 Objective 1:

To perform the quantitative and qualitative analysis of antinutrients factors in rice bean

The effect of different processing techniques on the antinutritional factors of rice bean will be investigated for the following processing technqiues:

Soaking

The rice beans will be soaked in potable water (seed-water, 1:10 w/v) for variable time viz: 6, 12, 24, 48, 96 hours at room temperature (Nakitto et al. 2015).

Germination

The soaked beans will be allowed to germinate in sterile petri dishes lined with filter paper for 24, 48, 72, 96 hours in dark and will moistened at regular interval of 12 hours (Kalpanadevi et al. 2013).

Roasting

The seeds will be roasted at 180, 200, 220ºC for 5, 10 and 15 min each in sand taken in open pan, at 170°C for 10, 15, 20, and 25 min. in oven and in microwave oven at different powers viz: 450, 600, 900 W and at different time combinations of 5, 10, 15 min. (Jogihalli et al.2017; Nakitto et al. 2015).

Cooking

The cooking of soaked and unsoaked beans will be done in the boiling water with seed to water ratio 1:5[w/v] and 1:6 [w/v] for soaked and unsoaked beans respectively for 5, 10 and 15 minutes (Dsouza 2013).

The pressure cooking of soaked and unsoaked beans will be done with seed to water ratio 1:3[w/v] and 1:2[w/v] for unsoaked and soaked beans respectively for 5, 10 and 15 minutes (Sinha et al. 2003).

Detection of antinutrients by FTIR and Quantitative spectrophotometry

a) Tannins (Ricci et al. 2015, Nour et al. 2015)
b) Phytic acid (Lewis et al. 2017, Nour et al. 2015)
c) Saponins (Almutairi et al. 2014, Sundaram et al. 2013)
d) Trypsin inhibitor (Zhang et al. 2008, Bepary et al. 2016)

The effect of different processing techniques on the antinutritional factors of chickpea will be investigated for the following processing technqiues:

Soaking

The chickpea will be soaked in potable water (seed-water, 1:10 w/v) for variable time viz: 6, 12, 24, 48, 96 hours at room temperature (Nakitto et al. 2015).

Germination

The soaked chickpea will be allowed to germinate in sterile petri dishes lined with filter paper for 24, 48, 72, 96 hours in dark and will be moistened at regular interval of 12 hours (Kalpanadevi et al. 2013).

Roasting

The seeds will be roasted at 180, 200, 220ºC for 5, 10 and 15 min each in sand taken in open pan, at 170°C for 10, 15, 20, and 25 min. in oven and in microwave oven at different powers viz: 450, 600, 900 W and at different time combinations of 5, 10, 15 min. (Jogihalli et al.2017,Nakitto et al. 2015).

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Detection of antinutrients by FTIR and Quantitative spectrophotometry

a) Tannins (Ricci et al. 2015, Nour et al. 2015)
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c) Saponins (Almutairi et al. 2014, Sundaram et al. 2013)
d) Trypsin inhibitor (Zhang et al. 2008, Bepary et al. 2016)

5.1.2 Objective 2:

To prepare ready to eat premix for elderly people using rice bean

The obtained optimized condition with maximum reduction in anti-nutrient in rice beans will be used to select the processing condition to develop the ready to eat premix for a target population of elderly people considering various factors as:

i. Anorexia of aging (Soenen et al. 2013)
ii. Sarcopenia (Brownie 2006)
iii. Xerostomia or Dry mouth (Ho et al. 2017)
iv. Changes to gastrointestinal tract
    - Oral changes
    - Atrophic gastritis (Brownie 2006)
v. Sensory changes: Taste and Smell (Ministry of Health 2013)
vi. Changes in food intake (Ministry of Health 2013)

Five parameters rice bean, chickpea, lactose free milk powder, natural non-nutritive sweetener (stevia) and SMP will be used as a variable for optimization of the geriatric premix. Respronse surface methodology will be used to optimize the ingredients for the premix. Above variables will be analyzed for the following parameters.

A. Physical analysis

1) Solubility (Wani et al.2013)
2) Flowability (Emesu et al. 2013)
3) Wettability (Olawuni et al. 2013)
4) Bulk density (Wani et al. 2013)
5) Dispersibility (Jaya et al. 2004)
6) Foaming properities (Mundi et al. 2012)

B. Chemical analysis:

a) Proximate Analysis (AOAC 2005)
b) Free fatty acid content (FFA) (Balogun et al. 2012)
c) Hydroxymethylfurfural content (HMF) (Capuano et al. 2009)
d) Thiobarbituric acid value (Ozvural et al. 2011)
e) Total phenolic acid content (Kamtekar et al. 2014)
f) Vitamin C content (Baba et al. 2016)

C. Antioxidant Activity

a) DPPH Radical Scavenging Activity (Rasane et al. 2014)

b) ABTS Free Radical Scavenging Activity (Khan et al. 2012)
c) FRAP Assay (Hassan et al. 2013)

D. Sensory analysis:

A 9 point hedonic scale will be used to evaluate the experimental samples using 100 semi trained panelists. Healthy male and female of suitable age will be selected for the evaluation.

Color and appearance
Flavor and sweetness
Body and texture
Mouthfeel
Overall acceptability

Expression	Points to be assigned
Liked extremely	9
Liked very much	8
Liked moderately	7
Liked slightly	6
Neither liked nor disliked	5
Disliked slightly	4
Disliked moderately	3
Disliked very much	2
Disliked extremely	1

Sample code	Color and appearance	Flavor and sweetness	Body and texture	Mouthfeel	Overall acceptability	Remarks (if any)

Optimized product will be obtained using the above experimental setup.

5.1.3 Objective 3:

To study the shelf life of the developed geriatric premix

The developed an optimized, ready to eat geriatric premix will be packed using different packaging material viz. LDPE, HDPE and Metalized polyester. Further, stored at three different temperatures 10, 25 and 37 °C. The packaged products will be stored for 3 months and analyzed for following parameters at regular intervals of 7 days.

E. Microbial Analysis

i. Colic form analysis (FSSAI 2012)
ii. Estimation of yeast and mould (FSSAI 2012)
iii. Total plate count (FSSAI 2012)

F. Physical analysis

7) Solubility (Wani et al.2013)
8) Flowability (Emesu et al. 2013)
9) Wettability (Olawuni et al. 2013)
10) Bulk density (Wani et al. 2013)
11) Dispersibility (Jaya et al. 2004)
12) Foaming properities (Mundi et al. 2012)

G. Chemical analysis:

g) Proximate Analysis (AOAC 2005)
h) Free fatty acid content (FFA) (Balogun et al. 2012)
i) Hydroxymethylfurfural content (HMF) (Capuano et al. 2009)
j) Thiobarbituric acid value (Ozvural et al. 2011)
k) Total phenolic acid content (Kamtekar et al. 2014)
l) Vitamin C content (Baba et al. 2016)

H. Antioxidant Activity

d) DPPH Radical Scavenging Activity (Rasane et al. 2014)
e) ABTS Free Radical Scavenging Activity (Khan et al. 2012)
f) FRAP Assay (Hassan et al. 2013)

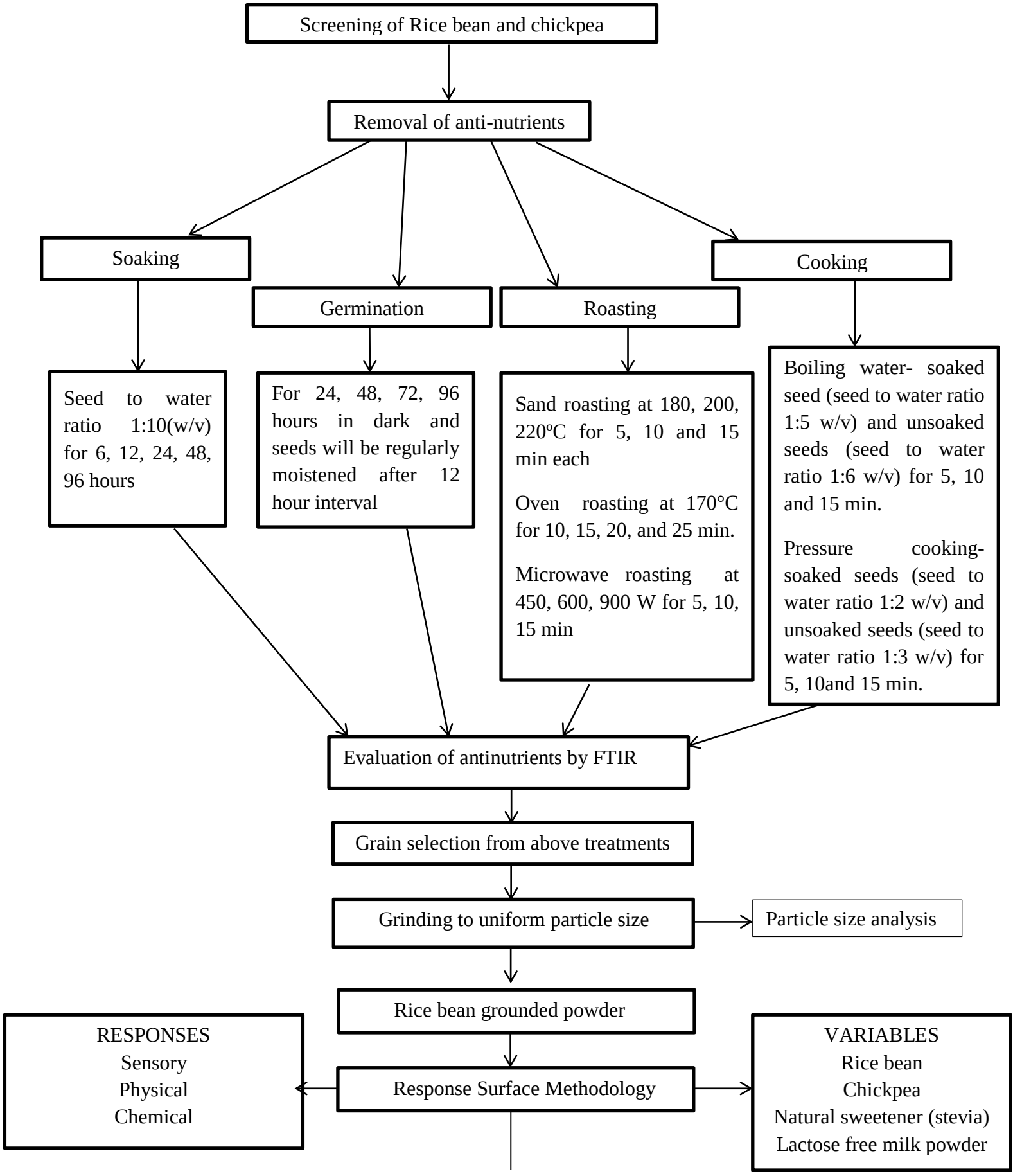
I. Sensory analysis:

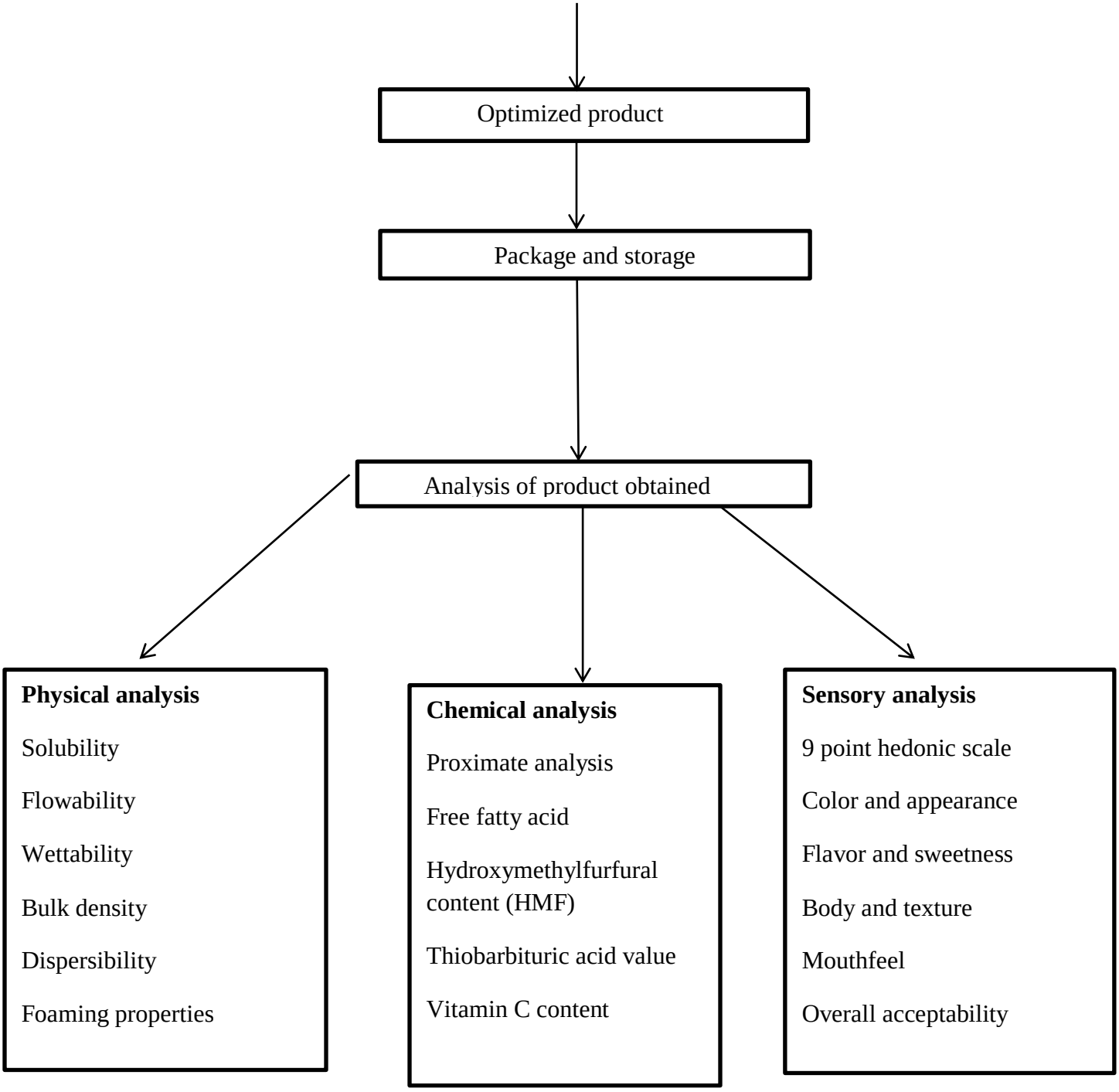
A 9 point hedonic scale will be used to evaluate the experimental samples using 100 semi trained panelists. Healthy male and female of suitable age will be selected for the evaluation.

Color and appearance
Flavor and sweetness
Body and texture
Mouthfeel
Overall acceptability

Expression	Points to be assigned
Liked extremely	9
Liked very much	8
Liked moderately	7
Liked slightly	6
Neither liked nor disliked	5
Disliked slightly	4
Disliked moderately	3
Disliked very much	2
Disliked extremely	1

Sample code	Color and appearance	Flavor and sweetness	Body and texture	Mouthfeel	Overall acceptability	Remarks (if any)


Screening of Rice bean and chickpea
Removal of anti-nutrients
Soaking
Germination
Roasting
Cooking
Seed to water ratio 1:10(w/v) for 6, 12, 24, 48, 96 hours
For 24, 48, 72, 96 hours in dark and seeds will be regularly moistened after 12 hour interval
Sand roasting at 180, 200, 220ºC for 5, 10 and 15 min each
Oven roasting at 170°C for 10, 15, 20, and 25 min.
Microwave roasting at 450, 600, 900 W for 5, 10, 15 min
Boiling water- soaked seed (seed to water ratio 1:5 w/v) and unsoaked seeds (seed to water ratio 1:6 w/v) for 5, 10 and 15 min.
Pressure cooking- soaked seeds (seed to water ratio 1:2 w/v) and unsoaked seeds (seed to water ratio 1:3 w/v) for 5, 10and 15 min.
Evaluation of antinutrients by FTIR
Grain selection from above treatments
Grinding to uniform particle size
Particle size analysis
Rice bean grounded powder
RESPONSES
Sensory
Physical
Chemical
Response Surface Methodology
VARIABLES
Rice bean
Chickpea
Natural sweetener (stevia)
Lactose free milk powder


Optimized product
Package and storage
Analysis of product obtained
Physical analysis
Solubility
Flowability
Wettability
Bulk density
Dispersibility
Foaming properties
Chemical analysis
Proximate analysis
Free fatty acid
Hydroxymethylfurfural content (HMF)
Thiobarbituric acid value
Vitamin C content
Sensory analysis
9 point hedonic scale
Color and appearance
Flavor and sweetness
Body and texture
Mouthfeel
Overall acceptability

Chapter 6: EXPECTED RESEARCH OUTCOME

1. Potential anti-nutrient reduction process for rice bean and chickpea will be achieved.
2. A geriatric premix acceptable on sensory, physical and chemical parameters will be developed.
3. The obtained optimized product will be evaluated for shelf life and an optimum shelf life will be predicted.

Chapter 7: References

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