DEVELOPMENT AND QUALITY EVALUATION OF GERIATRIC HEALTH MIX

by

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THESIS

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DECLARATION

I, hereby declare that this thesis entitled "Development and quality evaluation of Geriatric health mix" is a bonafide record of research work done by me during the course of research and the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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DEDICATED TO

MY

FAMILY AND FRIENDS

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LIST OF ABBREVIATIONS

NDP CAL %	-	Net dietary protein percent
Fig	-	Figure
g	-	Gram
100g	-	100 gram
mg	-	milligram
Kcal	-	Kilocalories
Meq/k	-	milliequivalent per kilogram
Cfu/g	-	colony forming unit per gram
%	-	Percent
et al	-	and others

INTRODUCTION

INTRODUCTION

"Geriatric", is an alternative term for a senior and elder person. A geriatric person is that individual, who is in the last stage of life, which follows adulthood and precedes the death of the person.

The term "older adults" are those who belong to the age group of over 65 years of age. In India, an age of 60 years and above is considered as older adult or geriatric. In developed countries like United States an individual at 65 years is designated as elderly or older adult or geriatric (edukalife.blogspot.in, 2013).

Technological, social, cultural and demographic transitions have taken place in India during the past few years. Along with these, awareness of health care among the people has also taken place in India, which leads to the improvement in the quality of health care facilities. Mortality rate of Indians has come down due to an increase in their life expectancy, this increase in life expectancy, in turn leads to increase in older population. In India elderly population aged 60 years or older is steadily increasing (Nair *et al.*,2015).

Geriatrics are a rapidly growing population. As age increases their health status diminishes and they are more vulnerable to diseases (Nyberg *et al.*, 2015).

Society does not give any importance to the nutrition and health of the elderly. They are often neglected. Most of the nutritional intervention programmes are directed towards infants, young children, adolescents, pregnant and lactating mothers. However, nutrition plays an important role in the prevention of degenerative conditions of the elderly and it also improves their quality of life (Jones *et al.,* 2008).

Diet and lifestyle are coupled to make an ill-free and healthy body. Therefore, maintaining a good diet and life style are important for the health for all age groups. Maintaining a well-balanced diet is one of the main factors to stay healthy for all age groups. Older adults are not exceptional in the case of healthy eating (Jones *et al.,* 2008).

Food and nutrition affects the health of older people. Dietary intakes and nutritional status of an older adult is related with healthy ageing. As people gets older, a special attention about nutrition is essential for their good health (Basran and Hogan, 2002)

Protein-energy malnutrition is an important nutritional deficiency condition that is faced by all the age groups from infants to older adults. This type of malnourished condition can be controlled to a large extent by introducing healthy mixes of good quality and quantity, at the right time in the right proportions (Lohekar, 2014).

Health mix is defined as the semisolid food given to all age groups from an infant of 6 months to geriatrics. Ramasri (2013), developed a health mix based on millets such as finger millet and foxtail millet and pulses like green gram to provide adequate nutrition to the targeted groups. This was found to be easily digestible to all age groups.

Several commercial healthy mixes are available in India, but they are too expensive for the population belonging to the low income family, especially those in the rural areas (Lohekar, 2014).

Several studies have shown that the use of oral nutritional supplements in malnourished people of community may reduce health complications and mortality (Roberts and Dallal, 2005).

In view of the above aspects, Geriatric health mixes were developed and evaluated for their nutritional, functional, organoleptic and shelf stability. These health mixes had enhanced levels of nutrients and health promoting components.

REVIEW OF LITERATURE

2. Review of literature

The literature reviewed for the present study entitled "Development and quality evaluation of Geriatric Health mix" is presented under the following headings.

2.1. Ageing

2.2. Nutritional status of older adults

2.3. Importance of nutrition in older adults

2.4. Health problems of older adults

2.5. Nutrient requirements

2.1. AGEING

An important fact of life is that our body changes with age. Ageing means the process of becoming older. Physiological, psychological and immunological changes occur in body during the process of ageing, which in turn influence the nutritional requirements. In the process of ageing, the external body changes are the graying of hair, wrinkling of skin and also the degeneration of eyes and ears (Singh and Mishra, 2013).

Aging refers to the multi-dimensional process of physical, psychological, and social change. The elderly population are extremely diverse, ranging from very fit, active, and healthy octogenarians to extremely frail, totally dependent people with chronic diseases and severe disabilities. The burden of disease in this population is clear and this in turn influences the nutritional status of this population. (Nyberg *et al.*, 2015).

It is universally accepted reality that, as age increases the elderly become more vulnerable to illness and their health problems are more prone to increase with age (Sivaraju, 2002).

Ageing process includes a reduction in strength, endurance, speed of reaction, agility, basal metabolism, sexual activity and hearing acuity. The bones become more brittle, the skin drier and less elastic and the teeth start shedding. Poor nutrient intake and poor absorption of nutrients have affected the changes and chronic illness of elderly people (Barja, 2004).

2.2 Nutritional status of older adults

Studies done by Raju *et al.*, (2002) revealed that the number of aged 65 and above were increasing at 2.8 per cent per year. The world's older population increases by 1.2 million persons per month. More than 80 percent of the older population increases in developing countries and this growth rate of the aged is 3 times as high as in developed countries. Studies show that by the year 2020 there will be over 1000 million older people in the world and 710 million older people in developing countries.

In India, the second most populous country in the world, the proportion of those 60 years and older was 5.4 per cent in 1951, and it increased to 8.0 per cent in 2011 (Nair *et al.*, 2015).

Since 1981 every year Kerala has been adding one million elderly population till 2000. According to 2011 Censes, more than 12 per cent of Kerala's population comprises the elderly. In terms of the proportion of elderly in the population in 2001 as well as 2011, Kerala ranks first, with Punjab and Himanchal Pradesh occupying the second position, followed by Tamilnadu and Maharashtra (Express News Service, 2014).

Agarwalla *et al.*, (2015) conducted a study in Assam and reported that 15 per cent of the elderly were malnourished and 55 per cent were at risk of malnourishment.

Studies conducted on 3,932 older adults in 9 provincial States of India revealed that consumption of foods and intake of all the nutrients were below the Recommended Dietary Intakes (RDI) in both men and women (Arlappa *et al.,* 2007).

Study done in rural Tamil Nadu by Vedantam *et al.*, (2010) conducted that 14 per cent of the elderly were malnourished. Nutritional status assessment done in out of 500 elderlies in Cochin, revealed that 'at risk' elders were 39.6 per cent and malnourished were 6.8 per cent (Shilpa and Kumari, 2014).

It is estimated that between 2 per cent-16 per cent of elderly are nutritionally deficient in protein and calories (Whitehead and Finucane, 2005).

About 23 per cent of the elderly population have difficulties with one or more activities of daily living such as bathing, dressing, toileting, continence, feeding, mobility. 28 per cent of elderly have difficulty with one or more instrumental activities of daily activities such as shopping, preparing meals, taking medication etc. Any of these areas of function is a risk factor for the elderly population (Unosson *et al.,* 2002).

2.3. Importance of nutrition in older adults

Nutrition plays an important role in the health of elderly people. Over the age of 65 the importance of nutritional status has been increasing day by day in a variety of morbid conditions including cancer, heart diseases and dementia (Basran and Hogan, 2002).

Maintaining a good nutritional status assures a healthy well being. This promotes health related quality of life, reducing the risk of developing diseases, thus promoting continued independent living (Chernoff, 2001).

Nutritional care for older adult is an unavoidable agenda both internationally and nationally (Pirlich and Lochs, 2001). Most of the nutritional programmes are

directed towards infants, young children, adolescents, pregnant and lactating mothers; but they are not considered about older people (Jones *et al.,* 2008).

Health of older people is influenced by many factors like age, gender, lifestyle habits, education, food habits, residence, marital status, financial wellbeing and family structure. As age increases they are more vulnerable to diseases. A proper diet or nutrition is an important requirement of the living body. Along with this good diet and nutrition is essential for the individual to function normally. Nutrition of the aged is determined on the basis of their earlier food habits, food choices, food likes, dislikes, the consumption pattern within the family, their diet during illness, food beliefs, food restrictions and digestion problems during their old age (Sivaraju, 2002).

2.4. Health Problems of older adults

Along with ageing the risk of malnutrition is also increasing. Thus resulting in poorer health and higher risk of diseases. The burden of disease on the older population is the reason for the poor nutritional status of this population (Nyberg *et al.,* 2015).

Pirlich and Lochs (2001) reported that malnutrition in elderly is due to somatic, psychic or social causes. It leads to chewing or swallowing disorders, cardiac insufficiency, depression, social deprivation and loneliness.

Brown and Kuk (2014) viewed that obesity is associated with negative health outcomes in older adults.

Several longitudinal studies have reported that obese older adults were at a significantly higher risk for developing arthritis and type 2 diabetes (Janssen, 2007).

Compher *et al.*, (1998) found that as age advances renal function declines. This will lead to decreases responsiveness to antidiuretic hormone, which results in an

increased risk for dehydration in older patients. This condition makes it difficult to replace fluid losses. Renal impairment also affect vitamin D metabolism and it results in a reduction of vitamin D levels, which is the reason for osteoporosis in the older people.

2.4.1. Sarcopenia

As age increase, body composition changes dramatically. The term 'sarcopenia' means loss of muscle mass. Muscle mass declines by 1–2 percent each year after the age of 50 years. As age increases loss of muscle mass also increases (Rolland *et al.,* 2008). Both genetic and environmental factors influence sarcopenia (British Nutrition Foundation, 2009).

Women have a sudden decline of muscle mass after the menopause and in the case of men sarcopenia is a gradual decline of muscle mass (Rolland *et al.*, 2008). Sarcopenia results in the reduction in muscle strength, which leads to a decline in physical function, impaired mobility and balance. however, muscle mass and strength can be improved through a combination of physical activity and good nutrition (Rolland *et al.,* 2008).

2.4.2. Arthritis

Arthritis is a group of diseases which includes inflammation on joints. Prolonged inflammation leads to long-term pain and deformity. Osteoarthritis is the common type of arthritis and mostly seen in the elderly and it results in the pain in hip and knee joints, which leads to disability and it affects the functional capacity (Ministry of Health, 2008).

2.4.3. Bone loss

The loss of bone and total body calcium is related with ageing (WHO, 2002). Bone loss usually starts at around 50 years of age in women and 65 years of age in men (WHO, 2003). Calcium absorption will decrease with increasing age in both genders. Adequate amount of calcium and vitamin D intake is necessary for minimizing bone loss (NHMRC, 2006).

Thinning and shrinkage of bones occurs on older people. This results in a loss of height of about two inches by age 80, which leads to a stooping posture in many people (Karl, 2000)

2.4.4. Gastrointestinal and immune functions

Gastrointestinal functions may decrease as age advances. The strength and elasticity of the intestinal wall will decrease, resulting in slower intestinal motility. Atrophic gastritis which results in reduced secretions of gastric acid which will reduce the bioavailability of vitamin B12, folate, calcium and iron (Phillips, 2003).

The immune system may disfunction with ageing which results in poor recovery from disease. Following a good nutrition can contribute to an increase in immune status (WHO, 2002).

Immune system needs good nutrition for the individuals over the age of 65. Malnutrition will increase the risk of sepsis in the elderly population. The elderly is more likely to die with infections than young adults. Impaired immune function will more difficult for older people, as they cannot eat enough to keep up with elevated energy demands (Potter *et al.,* 1998).

2.4.5. Oral health and dentition

Good oral health and dentition are influenced by good nutrition. Oral health is defined as the ability to chew food, with adequate teeth and saliva flow. Those with ill-fitting dentures, are restricted to eat variety of foods (Phillips, 2003). Older adults with their ill- fitting teeth have pain while chewing and this may discourage the consumption of nutritious foods that are difficult to chew, such as some vegetables, fruit and nuts and some meats. These type of problems will affect the enjoyment of eating and decrease the nutrient intake (Marshall *et al.*, 2002).

Elmadfa and Meyer, (2008) reported in their study that micronutrient intakes can be influenced by oral health.

Less saliva and less ability for oral hygiene in old age increases the chance of tooth decay and infection. Swallowing of food without proper chewing results to digestive problems (Morais *et al.*, 2003).

2.4.6. Taste and smell

Taste and smell decreases with age, which may affect food intake. This is a common problem among elderly people who complain of a loss of both taste and smell. They lose a number of taste buds on the tongue, which affect the older adult's capacity to distinguish between sweet, sour and salty flavors. This will lead to loss of appetite and also their interest in food. This condition will also reduce their ability to detect bad odors in spoiled foods (Watson, 2006).

2.4.7. Constipation

It is a common problem in older adults. With increasing age, motility of large intestine and elasticity of the rectal wall decreases because of the decrease in muscle

activity, which leads to constipation. Constipation is because of many factors such as reduced fibre intake and fluid intake, decreased physical activity and multiple medications (Bosshard *et al.,* 2004).

2.4.8. Polypharmacy

Polypharmacy which means the use of more than five medications at a time. Poly pharmacy increases in the older age group. Usage of multiple medications in older people are at high risk of food–drug interactions, which may affect their food intake and normally decline the nutritional status of the them. After effects of multiple medications are dry mouth, taste impairment, anorexia, depression, dehydration, electrolyte abnormalities, diabetes, osteoporosis and parkinsonism (Martin *et al.,* 2002).

2.4.9. Psychological factors

Various psychological factors which affect the nutritional status of older people. Depression is one of the psychological factors faced by older people (Chapman and Perry, 2008). As a result of depression, they become unable to do physical tasks, including cooking and eating, which will affect their appetite (Griep *et al*., 2000).

Depression in older people may be associated with chronic diseases like obesity (Chapman and Perry 2008). Depression is also associated with loss of social networks. Social isolation is another problem faced by older people. Social isolation will affect food intake and reduce the motivation to eat (Donini *et al.,* 2003).

The aged, face a lot of psychological problems like reduced income, isolation, the loss of friends or a spouse or depression, age associated disability, lack of supervision, deteriorating mental function which will lead to loneliness that in turn may

affect the older people to adopt poorer eating habits. Interest in food and cooking deterioration and therefore they eat too little (Goyal and Goyal, 2002).

Hearing loss causes difficulties with communication. This leads older people to frustration, low self-esteem, withdrawal and social isolation (Kackar, 2010).

Loneliness leads to decreased intake of food. Low in interest to food make forgetting them to eat proper meals. They like to eat with others rather than by oneself (Wylie *et al.*, 1999).

Studies has shown that older people living with their partners are better and healthier and live longer than those without partners (Barrett *et al.,* 2006).

A lack of adequate income is a reason of inadequate food intake in some older adults. Limited amount of money cannot meet the needs and requirements of older adults. Therefore, they are not able to access healthy and safer foods which leads to the nutritional status of the elderly people (Barrett *et al.,* 2006).

Elderly may experience food insecurity because of in adequate money. Lack of physical and mental ability to make meals and living alone. Transport limitations to reach food outlets can all contribute to food insecurity (Lee and Frongillo, 2001).

2.5. Nutrient requirements

Ageing is mainly associated with decrease in taste acuity and smell, deteriorating dental health, and decreases in physical activities, which may affect nutrient intake (Hickson, 2006).

Older people require less energy than young people because of a reduction in the levels of activity. Energy requirement is based on a number of factors such as age, gender, body composition, weight, and activity levels. Mainly, energy requirements decrease due to loss of fat-free mass. Less energy requirements are a risk of older people to meet the micronutrient requirements in their diet. Therefore, keeping a good diet is a prime importance to ensure that deficiencies do not develop. Older people should be encouraged to meet their energy requirement through a healthy diet.

Proteins are essential to build and repair tissues, for hormone, enzyme and antibody synthesis and for many other body functions. Inadequate protein intake in older people is associated with increased skin fragility, decreased immune function, poorer healing and longer recuperation from illness. Although muscle mass decreases in older people, the formation of muscle protein can be stimulated by higher availability of protein and so it is imperative that an adequate protein intake is maintained (Chernoff, 2004).

Carbohydrates are energy-giving nutrients and the body needs carbohydrates for energy-yielding. As age advances, loss of teeth makes it difficult to chew food properly. Elderly people tend to consume more carbohydrate-rich food, because they require minimum chewing, are easily digested, need minimum cooking time, In the Indian dietary, 55 - 65 energy percent should be provided by carbohydrates. Elderly people should include whole cereals, pulses, fiber-rich fruits, and vegetables.

Athor (2014) reported that eating whole grain foods reduces the risk of digestive disorders, heart diseases, high cholesterol and various degenerative diseases as they contain complex carbohydrates and fibre.

Barley has high amounts of soluble fibre and addition of barley to a healthy diet may be effective in lowering total and LDL cholesterol (Behall *et al.,* 2004).

Oat-consumers had a significantly higher daily intake of fibre than those who did not consume oats. Two thirds of celiac disease patients preferred to use oats in their daily diet (Kaukinen *et al.,* 2013).

Finger millet (*Eleusine coracana*), one of the minor cereals, is an important staple food in India for people of low income groups. Nutritionally, its importance is well recognized because of its high content of calcium (0.38%) and dietary fibre (18%).They are also recognized for their health beneficial effects due to anti-diabetic, antioxidant and antimicrobial properties (Devi *et al.*, 2014).

Soya flour is rich source of proteins, as well as iron, B vitamins and calcium, and it adds pleasant texture and flavor to a variety of products. Soya flour is available in a full-fat form with all its natural oils, or in a "defatted" form, from which all the oils are removed during processing. "Defatted" soya flour provides a slightly higher percentage of protein and calcium. Both forms of soya flour have health benefits (Chew, 2013).

Fibre intake seems to be important in the elderly which necessitates the intake of fruits and vegetables in the daily diet (Donini *et al.,* 2009).

Overall caloric intake requirement in the elderly decreases while the need for other nutrients remains relatively unchanged. This makes eating nutrient dense foods even more important for older adults (Culross, 2008).

Diet plays an important role in preventing diseases in elderly. It has been shown that general health and quality of diet are determined by social support, socioeconomic status and culture (Kazemi *et al.,* 2011).

Food products available at present in the market may not be suitable for the elderly in terms of nutrition, physical characteristics, digestibility and cost. To prevent elderly persons from becoming under-nourished and to reduce the risk of non-communicable diseases, their meals should have a balanced energy and protein

distribution in terms of macro nutrients. It is appropriate to have cereal legume combination in their diet to achieve nutritional adequacy (WHO, 2002).

Keeping in view of the above aspects, the present study is taken up to develop a consumer acceptable geriatric health mix to targeted individuals that supplements the energy and nutrients missing in the diet.

MATERIALS AND METHODS

3. MATERIALS AND METHODS

The present study entitled "Development and quality evaluation of Geriatric health mix" was aimed to develop a consumer acceptable geriatric health mix to targeted individuals that supplement energy and other nutrients in the diet.

The methodology employed for the study is presented under the following headings.

3.1. Selection of the base materials.

3.2. Selection of other ingredients.

3.3. Standardization process of the health mix.

3.4. Optimization of the ingredients.

3.5. Acceptability trials of the health mix.

3.6. Standardization of recipes.

3.7. Consumer acceptability of the products.

3.8. Quality evaluation of geriatric health mix.

3.9. Shelf life study.

3.10. Statistical analysis.

3.11. Cost of product.

3.1. SELECTION OF THE BASE MATERIALS

Millet and cereals such as ragi, wheat rava, barley and oats are selected as base materials for the development of health mix. Base materials were collected from local shops. Wheat rava, barley and oats were roasted and then powdered and sieved.

Roasted ragi powder was brought as such from shop. These powdered form of wheat rava, ragi, barley and oats were packed in a plastic pouches. Plate No. 1 to 4 depicts the pictures of base materials.

3.2. SELECTION OF OTHER INGREDIENTS.

Ingredients viz. soya flour, dehydrated vegetables, dehydrated fruit bits, skimmed milk powder and food adjuncts were the other constituents in the formulation of health mix. Food adjunct added to it was cardamom.

Soya chunks were brought from the local shops and dried in a drier at 65 degree Celsius for 3 – 4 hours. This was powdered, sieved and packed in a plastic pouches. Green gram was roasted in a low flame for 10 minutes and then powdered sieved and packed in a plastic pouches.

Dehydrated vegetables included carrot, beans and onion. They were all purchased from local market. The carrots were washed and cleaned to remove dirt and dust. They were grated for easy drying. Grated carrot was dried at 65 degree Celsius for 7 – 8 hours. This was then powdered, sieved and packed in a plastic pouches.

Similarly beans were washed and cleaned to remove dirt and dust. They were cut in to round shape and dried at 65 degree Celsius for 6 – 7 hours. There was then powdered, sieved and packed in plastic pouches.

Onions were cleaned and washed to remove dirt. Cut the onion into very thin slices for easy drying. Sliced onions were dried at 65 degree Celsius for 9 – 10 hours. They were powdered, sieved and then packed in a plastic pouches.

Dehydrated fruit bits included dried pineapple, dates and Amla in honey. They were crushed and added. Dried pineapple, Dates and Skimmed milk powder

Plate 1. Ragi prepared for health mix

Plate2.Wheat rava prepared for health mix

Plate 3. Barley prepared for health mix

Plate 4. Oats prepared for health mix

Plate 5. Soya powder prepared for health mix

Plate 6. Dehydrated onion prepared for health mix

Plate 7. Dehydrated beans prepared for health mix

Plate 8. Dehydrated carrots prepared for health mix

Plate 9. Dates prepared for health mix

Plate 10. Dehydrated pineapple prepared for health mix

Plate 11. Amla in honey prepared for health mix

Plate 12. Skimmed milk powder for health mix

were purchased as such from the shops. Purchased Amla in honey was dried at 70 degree Celsius for 12 – 14 hours and then packed in a plastic pouches. Plate No. 5 to 12 depicts the pictures of other ingredients.

3.3 Standardization process of the health mix

Two groups of formulations were tried out for the finalization of geriatric health mix. From the Table 1, it can be seen that first group included treatments one to five and in Table 2, second group included six to ten. Dehydrated vegetables were used in the first group and dehydrated fruit bits were added in the second group along with base materials and other ingredients.

Table.1. Health mix formulations (Group 1)

Treatments	Combination of ingredients
T_1	Wheat rava + oats + pulse + dehydrated vegetables + skimmed milk powder
T_2	Wheat rava + barley + soya + dehydrated vegetables + skimmed milk powder
T_3	Wheat rava + ragi + soya + dehydrated vegetables + skimmed milk powder
T_4	Ragi+ oats + soya + dehydrated vegetables + skimmed milk powder
T_5	Ragi + barley + soya + dehydrated vegetables + skimmed milk powder

Table.2. Health mix formulations (Group 2)

Treatments	Combination of ingredients
T_6	Wheat rava+ oats + pulse + dehydrated fruit bits + skimmed milk powder
T_7	Wheat rava+ barley + soya + dehydrated fruit bits + skimmed milk powder
T_8	Wheat rava+ ragi + soya + dehydrated fruit bits + skimmed milk powder
T_9	Ragi + oats +soya + dehydrated fruit bits + skimmed milk powder
T_{10}	Ragi + barley +soya +dehydrated fruit bits + skimmed milk powder

3.4. Optimization of the ingredients

Proportions of base materials proposed in the health mix were 60 gram and other ingredients were 40 gram. Base materials and other ingredients were dried separately and blended to obtain various formulations. proportion of ingredients selected in the formulation of health mix were optimized based on the calorie and protein adequacy.

Energy and net dietary protein calorie per cent (NDP Cal %) were computed. From these combinations best 3 treatments were identified from each group. Table 3 depicts the combinations. From the first group T1, T4 and T5 were selected. From the second group T6, T9 and T10 were selected. The NDP Cal % was found out using the formula

$$\text{NDP Cal \%} = \frac{\text{protein calories} \times \text{CS} \times 100}{\text{Total calorie}}$$

Table. 3. Proportions of ingredients

Treatments	Ingredients
T_1	Wheat rava (40g) + oats (20g) + pulse (20g) + dehydrated vegetables (15g) + skimmed milk powder (5g)
T_4	Ragi (40g) + oats (20g) + soya (20g) + dehydrated vegetables (15g) + skimmed milk powder (5g)
T_5	Ragi (40g) + barley (20g)+ soya (20g) + dehydrated vegetables (15g) + skimmed milk powder (5g)
T_6	Wheat rava (40g) + oats (20g) + pulse (20g) + dehydrated fruit bits (15g) + skimmed milk powder (5g)
T_9	Ragi (40g) + oats (20g) + soya (20g) + dehydrated fruit bits (15g) + skimmed milk powder (5g)
T_{10}	Ragi (40g) + barley (20g) + soya (20g) + dehydrated fruit bits (15g) + skimmed milk powder (5g)

3.5. Acceptability trails of the health mix

Selected combinations of health mixes were processed into porridge using uniform procedure.

From these treatments best combination of each group were identified by sensory evaluation. Acceptability was done by a panel of ten judges.

3.6. Standardization of recipes

According to Tolute (2000), the procedure for recipe standardization begins with the process of recipe modification or adjustment. In the standardization procedure, 5 dishes were selected for both treatments. Products were steamed cake, dosa, oratty, porridge, and elayappam.

3.7. Consumer acceptability of the product

Acceptability of the developed health mix based dishes were assessed among 30 elderly people selected at random. The portion size of the health mixes were determined using food exchange list for easy adoption.

3.8. Quality evaluation of geriatric health mix

3.8.1. Sensory quality

Sensory quality evaluation plays an important role in acceptability study of a new product. Sensory characteristics like appearance, colour, flavor, texture, taste and overall acceptability of health mix were assessed by a panel of judges. These qualities were assessed using a score card (Jellinick, 1985) to find out the best combination of health mix.

Sensory evaluation of three treatments from each group was carried out by a panel of 10 judges by using a nine point hedonic rating scale. The major quality attributes included for scoring were appearance, colour, flavor and texture. The score

card was prepared and distributed among panel of judges to express their scores of healthmix.

3.8.2. Functional quality

Functional quality analysis helps in qualitative evaluation of a new product. Functional qualities like yield ratio, bulk density were studied in the developed health mix.

3.8.2.1. Yield ratio

The yield ratio of ingredients used for the formation of health mix was calculated by using the formula

$$\textbf{yield ratio} = \frac{\text{weight of health mix}}{\text{Weight of fresh health mix}}$$

3.8.2.2. Bulk density

Bulk density is the ratio of the weight of the sample to the weight of an equal volume of water. The sample was taken at a height of 20 cm in 50 ml beaker. It was leveled without compressing. The weight of the sample with the beaker was recorded. The sample was then removed from the beaker and water was filled to the same level. The weight of the water with beaker was recorded and calculated by using the formula.

$$\text{Bulk density} = \frac{\text{weight of the sample}}{\text{Weight of equal volume of water}}$$

3.8.2.3. Cooking characteristics

Cooking time and cooked weight were recorded for the understanding of cooking characteristics

3.8.3. Chemical composition

Chemical constituents namely moisture, acidity, total ash and peroxide value were calculated using standard procedure.

Moisture - Sadasivam and Manikkam (1992)

Acidity - Sadasivam and Manikkam (1992)

Total ash - NIN (1997)

Peroxide value - AOAC (1984)

3.8.4. Nutrient quality

Nutrient composition was ascertained with respect to

Carbohydrate - Sadasivam and Manikkam (1992).

Protein - AOAC (1984).

Iron - Sadasivam and Manikkam (1992)

Calcium - Sadasivam and Manickam (1992).

Potassium -Thimmiah (1999)

Sodium - Thimmiah (1999)

Fibre - Sadasivam and Manikkam (1992)

3.9.1. Shelf life study

The stored health mixes was assessed for the presence of various microorganisms such as bacteria, fungi and coliforms initially and at 30 days interval up to three months. This was done by serial dilution and plate count method suggested by Kramer and Gilbert (1977).

The developed health mix were packed in laminated pouches and stored up to three months. Storage qualities in terms of acceptability score, moisture content, acidity, peroxide value and microbial growth of each of the health mix were recorded at monthly intervals.

3.9.2. Sensory evaluation of stored health mixes

Assessment of sensory analysis of developed stored health mixes were done initially and at 30 days interval up to three months for evaluating acceptability of the health mixes.

3.10. Statistical analysis

In order to obtain meaningful interpretation, the generated data was subjected to suitable analysis.

3.11. Cost of production

Cost of production was analyzed based on the input cost, which means cost of different ingredients used for the preparation of health mixes, cost of packaging material and over head charges (20 percent of the cost of products were added as over head charges for fuel and labour to the input cost).

RESULTS

4. RESULT

The results of the present investigation entitled "Development and quality evaluation of Geriatric health mix" are detailed under the following heads:

4.1. Selection of base materials and other ingredients

4.2. Standardization process of the health mix.

4.3. Optimization of the ingredients.

4.4. Acceptability trails of the health mix.

4.5. Standardization of recipes and consumer acceptability of the product

4.6. Quality evaluation of geriatric health mix

4.7. Shelf life study

4.8. Cost of production

4.1. Selection of base materials and other ingredients

Millet and cereals such as Ragi, Wheat rava, Barley and Oats were selected as base materials for the development of the Geriatric health mix. Each of the raw materials were roasted, powdered and sieved. Soya, dehydrated vegetables, dehydrated fruit bits, skimmed milk powder and food adjunct were the other selected ingredients in the formulation of health mix. Vegetables such as onion, beans and carrot were dried, powdered and sieved. Dehydrated fruit bits such as dried pineapple and dates were crushed. Amla in honey was dried separately and makes it crushed.

4.2. Standardization process of the health mix

Two groups of combinations were proposed for the formulation of Geriatric health mix. Each group includes five treatments. In the first group dehydrated vegetables and in the second group dehydrated fruit bits were added along with the base materials and other ingredients.

4.3. Optimization of the formulations

From the proposed two groups of combinations, best three treatments of each group were selected; based on computed energy and NDP Cal%. Energy and NDP CAL% of each combination was computed to identify the best combination.

For older adults NDP CAL % of less than five per cent would be adequate to maintain good health.

TABLE 4. ENERGY AND NDP CAL % OF THE FORMULATIONS

(GROUP 1)

Treatments	Energy (Kcal)	NDP CAL%
T_1	295.38	4.56
T_2	307.38	4.25
T_3	305.78	4.24
T_4	310.03	5.19
T_5	299.38	5.34

From the above Table it is clear that in first group (T_1 to T_5) energy varied from 295.38 to 310.03 KCals. In the first group the NDP CAL % of T_1, T_4 and T_5 was higher than the other treatments. Energy was lower in T_1 and T_5. These variations are the result

of the difference in combinations of the ingredients. T_4 had highest energy (310.03). From this it is clear that T_1, T_4 and T_5 comprised of the optimum proportion of ingredients. So T_1, T_4 and T_5 were selected as best combinations.

TABLE 5. ENERGY AND NDP CAL % OF THE FORMULATIONS

(GROUP 2)

Treatments	Energy (Kcal)	NDP CAL%
T_6	309.93	4.08
T_7	322.01	3.69
T_8	320.41	3.67
T_9	321.61	4.56
T_{10}	314.01	4.68

In the second group (T_6 to T_{10}) energy varied from 309.93 to 322.01 KCals. NDP CAL % of T_6, T_9 and T_{10} were higher than other treatments. So T_6, T_9 and T_{10} were selected as best combinations.

TREATMENTS PROPOSED FOR THE FORMULATION OF HEALTH MIX

Treatments proposed for the formulation of Geriatric health mix was depicted in the given Table 6.

Table 6. Treatments proposed

Treatments		Ingredients	Proportions (g)
Group 1	T_1	Wheat rava+ oats +pulse +dehydrated vegetables+skimmed milk powder	40 +20 + 20 +5 +5 + 5+ 5
	T_4	Ragi+ oats + soya + dehydrated vegetables+skimmed milk powder	40 +20 + 20 +5 +5 + 5+ 5
	T_5	Ragi + barley + soya + dehydrated vegetables+skimmed milk powder	40 +20 + 20 +5 +5 + 5+ 5
Group 2	T_6	Wheat rava+ oats +pulse +dehydrated fruit bits +skimmed milk powder	40 +20 + 20 +5 +5 + 5+ 5
	T_9	Ragi + oats +soya +dehydrated fruit bits +skimmed milk powder	40 +20 + 20 +5 +5 + 5+ 5
	T_{10}	Ragi + barley +soya +dehydrated fruit bits +skimmed milk powder	40 +20 + 20 +5 +5 + 5+ 5

4.4. Acceptability trails of the health mix

4.4.1. Sensory evaluation of group 1 formulation

Among them the three treatments of combinations were scored for selecting best combination of health mix. Each treatment was processed into porridge form and then served hot to the sensory panel members. Plate 13 shows the rating of sensory quality with respect to appearance, colour, flavor, texture, taste and overall acceptability were selected for the study. Sensory evaluation of group1 health mix is depicted in Table 7.

Table 7. Sensory evaluation of group 1 formulation

Treatments	Appear-ance	Colour	flavor	Texture	Taste	Overall-Accepta bility
T_1	8.20	11.85	12.00	6.40	8.50	8.65
T_4	25.50	20.15	18.95	24.70	25.15	24.60
T_5	12.80	14.50	15.55	15.40	12.85	13.25
CV (0.05)	5.99					

(Scores indicated are mean rank values)

Appearance

First impression of food is always its appearance. The highest mean rank value for appearance was T_4 (25.50), which was the combination of ragi, oats, soya, dehydrated vegetables and skimmed milk powder. The score of T_4 was observed to be

significantly higher than other two treatments. Lowest mean rank for appearance was T_1 (8.20). Mean score of T_5 was 12.80.

Colour

Colour is one of the major attributes used to judge the overall acceptability of the food. T_4 was noted as the highest mean rank score (20.15). T_1 recorded lowest mean rank score (11.85). T_5 was obtained mean rank score of 14.50. Treatments were found to be significant.

Flavor

Odour is generated by stimulation of sensory cells by specific volatile compounds present in the food. Highest mean rank was obtained by T_4 (18.95) and least value was obtained by T_1 (12.00). Mean rank value for T_5 was 15.55. T_4 was found to be on par with T_5. T_1 was significantly different from T_4 and T_5

Texture

Texture constitutes the physical property of a food stuff. That can be felt with the fingers, tongue, palate or teeth. Different combinations of three treatments varies in their scores and T_4 shows maximum score of (24.70) and lowest score secured by T_1 (6.40). Mean rank score for T_5 was 15.40. scores which obtained by T1, T_4 and T_5 had significantly different values.

Taste

Taste is one of the important attributes for the acceptability of a food products. Taste is the aesthetic appreciation of the mouth. Superior taste was observed in T_4 (25.15) and least was found in T_1 (8.50). The score of T_5 was (12.85). The three scores of treatments were significantly different from each other.

Overall acceptability

Overall acceptability was computed by the sum total of scores of all the parameters. T_4 obtained the highest acceptability score of 24.60 and therefore T_4 had the highest preference. Less preference was recorded for T_1 (8.65) and T_5 (13.25). The three scores of different formulations were statistically different.

Results showed that, by the sensory evaluation T_4 obtained highest rank in all sensory parameters when compared to other two treatments and they were significantly different with each parameter. Along with this T_4 had higher NDP CAL %. Finally, T_4 from the first group was selected as best combination from first group.

4.4.2. Sensory evaluation of group II formulations

Sensory evaluation of group II depicted in the Table 8. Plate 14 depicts the picture of porridge prepared from T_6, T_9 and T_{10} for studying the acceptability of health mix.

Table 8. Sensory evaluation of second group

Treatments	Appear-ance	Colour	flavor	Texture	Taste	Overall-Acceptability
T_6	9.30	13.65	11.70	8.85	8.60	7.90
T_9	15.15	14.70	16.20	12.90	13.30	13.60
T_{10}	22.05	18.15	18.60	24.75	24.60	25.10
CV (0.05)	5.99					

(Scores indicated are mean rank values)

Appearance

Among T_6, T_9 and T_{10} formulations, T_{10} scored maximum mean rank value (22.05) for appearance, which was the combination of ragi, barley, soya, dehydrated fruit bits and skimmed milk powder. While formulation T_6 got the lowest mean rank value (9.30). Mean rank score of T_9 was 15.15. The mean rank values obtained for the treatments were found to be significantly different.

Colour

Colour is very important criteria for consumer acceptance of food products. T_{10} recorded the highest mean rank value (18.15). Least mean rank value (13.65) was obtained for T_6. T_9 got mean rank value of 14.70. The scores obtained for T_6, T_9 and T_{10} were significant.

Flavor

The maximum mean score for flavor was noted for T_{10} (18.60) while least mean rank value was obtained for T_6 (11.70). Mean score obtained for T_9 was 16.20. Score of T_9 was on par with T_{10}. T_6 was significantly different from T_9 and T_{10}.

Texture

T_{10} got the highest mean rank value (24.75) and T_6 got the least mean rank value (8.85). Mean rank value of T_9 was 12.90. The treatments showed significant difference amongst them.

Taste

Different combination of three formulations varied in their scores and T_{10} scored the maximum mean rank value (24.60) and lowest score was secured by T_6 (8.60). Mean rank score attained for T_9 was 13.30 and the values are significantly different.

Plate 13. Porridge prepared from T_1, T_4 and T_5 for studying acceptability of the health mix

Plate 14. Porridge prepared from T_6, T_9 and T_{10} for studying the acceptability of the health mix

Overall acceptability

Statistical analysis revealed that there was significant difference between the parameters of different combinations. It was noted that T_{10} obtained the highest mean rank value (25.10) in overall acceptability. Second position secured by T_9 (13.60) and third position was obtained by T_6 (7.90). Based on analysis of mean rank scores obtained for each parameter T_{10} was selected as best formulation from the second group. Plate 15 and 16 were depicted the pictures of health mix prepared from T_4 and T_{10}.

4.5. Standardization of recipes and consumer acceptability of the product.

Five types of dishes were selected with both formulations. The dishes were Elayappam, Oratty, Dosa, Porridge and Steamed cake. The scores of overall acceptability presented in the Table 9. On analysis the highest mean rank values were scored by the dish Elayappam. When prepared from T_4 the mean rank value of Elayappam was 35.96 and when prepared with T_{10} was 28.88. Oratty was obtained second highest mean rank value (33.93) when prepared from T_4. 28.58 was the mean rank value for oratty prepared from T_{10}. Dosa scored third position followed by porridge and steamed cake. Picture were depicted in plate 17, 18, 19, 20 and 21.

The scores obtained by T4 and T10 for Elayappam, oratty, dosa, porridge and steamed cake was significantly different.

Elayappam can be recommended as a snack. Oratty, Dosa and steamed cake can be recommended as break fast and porridge can recommended as dinner.

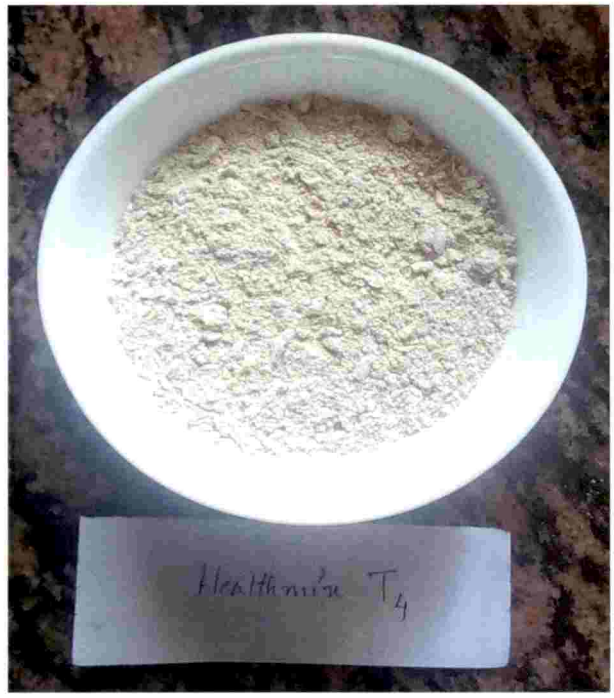

Plate 15. Health mix T_4

Plate 16. Health mix T_{10}

Plate 17. Steamed cake prepared from health mixes

Plate 18. Elayappam prepared from health mixes

Plate 19. Oratty prepared from health mixes

Plate 20. Porridge prepared from health mixes

Plate 21. Dosa prepared from health mixes

Table 9. Overall acceptability of the dishes

Treatments	Elayappam	Oratty	Dosa	Porridge	Steamed cake
T_4	35.96	33.93	33.50	32.41	32.11
T_{10}	28.88	28.58	27.50	27.06	25.03
CV (0.05)	3.841				

(Scores indicated are mean rank values)

4.5.1. Determination of portion size

From food exchange list, the total energy content of 100 gram of health mix was worked out as 310.03 for T_4 and 309.7 for T_{10} respectively. Energy requirement for sedentary adult man is 1883 Kcal and that for sedentary woman is 1782 Kcal based on "Nutrient requirement and recommended dietary allowance for Indians," by National Institute of Nutrition, ICMR, 2009. So, one portion of health mix will therefore be 200 gram. As this will meet one third requirement of the RDA. This amount can be had as one meal or two meals for this group.

4.5.2. Cooking characteristics

Cooking time – 20 gram of health mix and 250 ml of water took 10 minutes for cooking.

Cooked weight – 20 gram of health mix when cooked with 250 ml of water yielded 40 gram of product.

4.6. QUALITY EVALUATION OF GERIATRIC HEALTH MIX

4.6.1. FUNCTIONAL QUALITIES

Functional qualities help in the qualitative assessment and acceptability of any product. The functional qualities like yield ratio and bulk density were studied.

4.6.1.1. Yield ratio

Drying removes moisture by which the food shrinks and decreases in size and weight. Yield of the dried products directly related to the amount of water in the original product. The yield ratio of developed health mixes are given in the Table 10.

The data revealed that highest yield ratio was recorded for T_{10} (0.83). The least value was found for T_4 (0.45). The values showed significant difference statistically.

4.6.1.2. Bulk density

Bulk density is the important simple measurement for the analysis of solid foods. It is a property of dehydrated products. The volume of different food particles can be compared through bulk density. The bulk density of developed health mixes are given in the Table 10.

The results show that T_{10} had higher bulk density (0.66) and the least was observed for T_4 (0.55). The two combinations were significantly different in bulk density.

Table 10. Yield ratio and bulk density

Treatments	Yield ratio	Bulk density
T_4	0.45	0.55
T_{10}	0.83	0.66
CV (0.05)	0.01	0.01

(Values indicated are mean of 3 replications)

4.6.2. Nutrient composition in health mix

Nutrient composition of health mixes were determined with respect to energy (Kcal), carbohydrate (g), protein (g), fibre (g) and total minerals (mg). The results are shown in the Table 11.

Table 11. Nutrients in health mix per 100 gram

Treatments	Energy (Kcal)	Carbohydrate (g)	Protein (g)	Fibre (%)
T_4	310.03	54.07	18.80	7.50
T_{10}	309.72	54.21	17.98	7.87
CD (0.05)	0.003	0.02	0.01	0.043

(Values indicated are mean of 3 replications)

4.6.2.1. Calories

A calorie is a unit of energy. The amount of energy in a food items measured in calories. Energy value depends upon the amount of carbohydrate, protein and fat present in food items. Human body needs calories to survive.

Statistical analysis showed that energy value of T_4 was higher (310.03Kcal) when compared with T_{10} (309.72Kcal) and both values were statistically different.

4.6.2.2. Carbohydrate

Carbohydrate is one of the important nutrients. They are the important source of energy and are responsible for the production and regulation of blood glucose.

Given Table 11, gives the carbohydrate content of health mix. Data reveals that the amount of carbohydrate was higher in T_{10} (54.21g) than in T_4 (54.07g). There was significant difference between carbohydrate values of T_4 and T_{10}.

4.6.2.3. Protein

Protein is found throughout the body. They are the building blocks of life. Protein is important to replace worn out cells, transport substances throughout the body, and also aid in growth and repair. The protein consumption can help to control body fat.

From the Table 11, protein value of T_4 (18.80g) was higher than T_{10} (17.98g). There was significant difference between the mean values.

4.6.2.4. Fibre

Fiber is an important part of healthy diet. Foods rich in fiber help to feel fuller for longer. It improves the digestive health and help with weight loss. Fiber content in the health mix depicted in the Table 11.

Fiber content was found to be higher in T_{10} (7.87%) and less in T_4 (7.50%). There existed a significant difference in T_{10} and T_4.

4.6.2.5. Iron and calcium content of developed health mix

Iron and calcium content in the health mix is depicted in the Table 12

Table 12. Iron and calcium in health mix per 100g

Treatments	Iron (mg)	Calcium (mg)
T_4	5.08	272.52
T_{10}	4.43	270.45
CD (0.05)	0.01	0.06

(Values indicated are mean of 3 replications)

Iron is a part of all cells in our body. Iron helps our muscles store and use oxygen. Iron has a role in creating energy from nutrients. It helps to the transmission of nerve impulses. It is also essential for blood production. Iron plays an important role in immune system.

Iron content of the health mix revealed that the higher value was obtained by the T_4 (5.08mg). Least amount of iron was present in T_{10} (4.43mg). The mean rank score were significantly different.

Calcium is the most abundant mineral found in the body. Teeth and bones contain more calcium. Nerve cells, blood and other body fluids contain rest of the calcium. Maintaining good level of calcium in body helps to prevent osteoporosis.

Statistical analysis of calcium content in samples showed that T_4 (272.52mg) has high amount of calcium when it compares to T_{10} (270.45mg). Samples were significantly different.

4.6.2.6. Sodium and potassium content of developed health mix

Sodium and potassium content of the health mix is showed in the Table 13

Table 13. Sodium and potassium in health mix

Treatments	Sodium (mg)	Potassium (mg)
T_4	5.88	172.54
T_{10}	6.37	174.34
CD (0.05)	0.06	0.08

(Values indicated are mean of 3 replications)

Sodium is essential for life. Sodium helps to control fluid balance, helps to send nerve impulses and affect muscle function. And it controls blood pressure and blood volume.

From the table higher value of sodium was show by T_{10} (6.37mg). Lowest value shows T_4 (5.88 mg). The two values had significant difference.

Potassium is an essential body mineral. Body needs potassium to function normally. It is important to cellular and electric function. it plays an important role in heart, skeletal and smooth muscle contraction. It also helps in digestive function.

The results revealed that the treatments were significantly different. Highest mean rank value was recorded for T_{10} (174.34 mg) and least was recorded for T_4 (172.54 mg).

4.6.3. Chemical Composition

Chemical composition of developed health mix can ascertain with respect to moisture (%), acidity (%), total ash (g) and peroxide value (meq/kg).

4.6.3.1. Moisture and acidity content of the health mix

Moisture and acidity of the health mix is presented in the Table 14.

Table 14. Moisture and acidity of health mix per 100g

Treatments	Moisture (%)	Acidity (%)
T_4	2.60	0.20
T_{10}	3.04	0.29
CD (0.05)	0.32	0.03

(Values indicated are mean of 3 replications)

4.6.3.1.1. Moisture content of health mix

Moisture is one of the important parameters which affects the quality of the food product. Moisture affects the physical and nutritional composition of the developed products.

The mean value of moisture in T_{10} was 3.04% and in the case of T_4 were 2.60%. When it is compared T_{10} had highest moisture content. They were significantly

different. These values were in the safe range with respect to shelf life, because moisture content of dehydrated products should be 5-7 %.

4.6.3.1.2. Acidity of developed health mix

Acidity causes deteriorative changes in the food. Acidity of the developed health mix is shown in the table. The highest acidity value of formulated health mix was found at T_{10} (0.29%). The least value was 0.20 % for T_4. Values were not significant.

4.6.3.2. Total ash and peroxide value in health mix

Total ash and peroxide value in health mix in 100 g is depicted in the Table 15

Table 15. Total ash and peroxide value in health mix

Treatments	Total ash (g)	Peroxide value (meq/kg)
T_4	2.82	1.44
T_{10}	2.88	0.91
CD (0.05)	0.02	0.04

(Values indicated are mean of 3 replications)

4.6.3.2.1. Total ash content in the health mix

The statistical analysis of total ash content in the health mix revealed that the highest mean score was obtained by T_{10} (2.88) and least was scored for T_4 (2.82). T_4 and T_{10} were significantly different.

4.6.3.2.2. Peroxide content in the health mix

The data revealed that the scores obtained by T_4 and T_{10} were significantly different. Highest score of peroxide value was found in T_4 (1.44meq/kg). The lowest value obtained for T_{10} (0.91meq/kg).

4.7. Shelf life study of health mix

Assessment of shelf life quality is important for the product development. Raw material quality, storage temperature, storage containers and the environment in which the product processed affects the shelf life quality (Shankar, 1993). The shelf life quality of developed health mixes were analyzed by assessing the moisture content, acidity, peroxide value, microbial growth and acceptability of health mix up to a period of three months. Plate 22 depicts the picture of stored health mixes.

4.7.1. Peroxide value of stored health mix

Peroxide score gives the extent of per oxidation taking place in the stored food materials. Peroxide values are given in the below Table.

The Table 16 shows peroxide value of T_4 and T_{10} at initial level was 1.47meq/kg and 0.92meq/kg. At initial level T_4 scores the highest peroxide value. At the first month of storage T_4 scores 1.61meq/kg and T_{10} scores 0.97meq/kg. peroxide value was increased in first month. The scores obtained for initial and first month were significantly different for T_4 and there was no significant difference in the case of T_{10}. In the case of second month there was increase in peroxide value. The highest value was 1.83meq/kg for T_4 and least was 1.16meq/kg for T_{10}. Result of third month storage, peroxide value was increased in both treatments. 2.01meq/kg for T_4 and 1.44meq/kg for T_{10}. Highest mean rank score was 2.01meq/kg for T_4 at the end of third month. They are not significant.

Plate 22. Health mixes stored in laminated pouches

Table 16. Peroxide value in stored health mix per 100g

Storage periods	T_4	T_{10}
Initial	1.47	0.92
First month	1.61	0.97
Second month	1.83	1.16
Third month	2.01	1.44
CD (0.05)	0.03	0.11

(Values indicated are mean of 3 replications)

4.7.2. Moisture content in stored health mix

Moisture content in the stored health mix in laminate pouches was analyzed. The evaluation of product done periodically up to three months. The data given in Table 17.

Initial moisture content of T_4 was 2.03 per cent. After the thirty days the moisture content was increased to 2.80 percent. After the second month it was about 3.50 per cent and at the end of third month mean value was 4.23 percent. There was increase in moisture content from initial to third month.

As for T_{10} initial moisture content was 3.63 per cent. At the end of first month it was about 4.73 per cent. In the case of second month it was increase to 5.16 per cent. At the end of third month moisture content increased to 5.83 percent. There was

increase in moisture content from initial to third month. Moisture content in T_{10} was higher than T_4.

Table 17. Moisture content in stored health mix per 100g

Storage periods	T_4 (%)	T_{10} (%)
Initial	2.03	3.63
First month	2.80	4.73
Second month	3.50	5.16
Third month	4.23	5.83
CD (0.05)	0.22	0.34

(Values indicated are mean of 3 replications)

4.7.3. Acidity content in stored health mix

The acidity content of stored health mix for a period of three months is given in the Table 18.

Acidity of T_4 at the initial period was recorded it was 0.34%; it was the lower value obtain. Higher values were obtained at the third month which was 0.42%. At the end of first month acidity increased a little i.e. 0.36%. Acidity of initial and first month was on par. At the end of second month acidity increased to 0.40 % and at the end of third month acidity increased to 0.42%. Acidity value of second month was on par with acidity of third month.

Data reveals that acidity of T_{10} at initial period was lower (0.22%). At the first month acidity of the health mix was increased to 0.26%. this was again increased to 0.33% after second month. The highest score was obtained after three months (0.44%).

Table 18. Acidity content in stored health mix per 100g

Storage periods	**T_4**	**T_{10}**
Initial	0.34	0.22
First month	0.36	0.26
Second month	0.40	0.33
Third month	0.42	0.44
CD (0.05)	0.02	0.04

(Values indicated are mean of 3 replications)

4.7.4 Microbial study

Microbial growth in foods is an important factor which determines the quality of the food products. Many organisms causing food borne illness may grow on food products which lead to deterioration of the final product. Heat treatment during food processing can destroy vegetative pathogens. When foods are processed there are so many chances of contamination of food products even during storage period, since these microorganisms can multiply and cause spoilage in the product. Therefore, the assessment of microbial growth is a very important step in the product development.

In the present study, health mixes were stored at ambient condition for a period of three months (90 days). Microbial growth was recorded initially and also at 30 days intervals up to three months. Nutrient agar (NA), Rose Bengal agar (RB) and Eosin methylene blue agar (EMB) were used for the analysis of bacteria, fungi and coliforms respectively. This was done viable plate count method suggested by Kramer and Gilbert (1977). Results are given in the Table 19.

Table 19. Bacterial count in third month

Treatments	Dilution	
	10^6 ($\times$cfu/g^{-1})	10^7 ($\times$cfu/g^{-1})
T_4	5.3	1.3
T_{10}	1.6	-

(Values indicated are mean of 3 replications)

There was no microbial growth in initial, first and second month. At the end of the third month some growth was observed. Bacterial colonies of 5.3×10^6 cfu/g^{-1} and 1.6×10^6 cfu/g^{-1} were found in the T_4 and T_{10} treatments respectively. In 10^{-6} dilution, growth of bacteria was seen in T_4 and T_{10}. In the case of 10^{-7} dilution, bacterial growth of 1.3×10^7 cfu/$g^{-1}$was recorded in T_4 only.

4.7.5. Sensory evaluation of health mix during storage

Sensory evaluation plays an important role in acceptability and shelf life stability of the product. Sensory attributes are important factors which are susceptible to change during storage. Sensory evaluation was done to study the influence of storage

on the acceptability of the products. Changes in the two selected health mixes were carried out periodically with respect to the sensory parameters such as appearance, colour, flavor, texture taste and overall acceptability using score card by ten judges to understand the deteriorative changes occurring in the stored products. The samples were evaluated up to three months of storage. The results of appearance, colour, flavor, texture, taste and overall acceptability are presented in the Table 20.

4.7.5.1. Sensory evaluation of health mix (T_4) during storage

Table 20. Sensory evaluation of health mix (T_4) during storage

Treatments	Appear-ance	Colour	flavor	Texture	Taste	Overall-Acceptability
Initial	26.75	25.60	25.00	25.80	26.10	28.10
First month	22.15	22.05	22.20	21.05	21.25	22.45
Second month	20.10	19.90	20.45	19.10	19.95	20.45
Third month	13.00	14.40	14.35	16.05	14.70	19.00
CV (0.05)	7.815					

(Score indicated are mean rank values)

Appearance

Appearance is the criteria for desirability of food. Highest score in appearance was recorded at initial period (26.75). Least value was found on third month 13.00. Mean rank obtained for first month and second month were 22.15 and 20.10. There

was a decrease in score of appearance in second month than first month. Appearance of initial, first month and second month were on par and appearance of third month was statistically not significant.

Colour

Results revealed that the mean value for colour was higher initially (25.60). Mean rank value decreased after first and second month (22.05 and 19.90). After the third month the least scores obtained for colour was 14.40. Mean score of third month was not on par.

Flavor

As for flavor evaluation, highest mean rank value was scored at initial period (25.00). After the 30 days flavor values decreased slightly. Least value was obtained third month (14.35). First month and second month scored 22.20 and 20.45 respectively. Score recorded for flavor at third month was significantly different with initial, first and second month.

Texture

The scores obtained for initial time, first month and second month were not significant different. Texture scores ranged between 25.80 to16.05. Highest value was noted at initial time (25.80) followed by first month score (21.05), second month score (19.10). Least value was noted at third month (16.05).

Taste

Taste of health mix was recorded periodically. Mean rank value of initial period was distinguished with superior score of 26.10, followed by first month (21.25),

second month (19.95) and third month (14.70). Least mean rank was scored after third month. Results obtained at initial time, first month and second month were significant.

Overall acceptability

Sensory evaluation results revealed that appearance, colour, flavor, texture and taste of health mix at initial period scored highest (28.10). Mean rank values slightly decreased after 30 days interval up to three months. There was no significant deference between the scores. It means acceptability scores of the health mix (T_4) were acceptable up to three months.

4.7.5.2. Sensory evaluation of health mix (T_{10}) during storage

TABLE 21. Sensory evaluation of health mix (T_{10}) during storage

Treatments	Appear-ance	Colour	flavor	Texture	Taste	Overall-Acceptability
Initial	23.45	23.70	26.10	25.10	22.55	26.40
First month	23.40	23.10	25.20	24.20	21.50	23.10
Second month	22.80	22.60	18.75	19.05	20.20	21.72
Third month	12.35	12.60	11.95	13.65	17.75	17.81
CV (0.05)	7.815					

(Score indicated are mean rank values)

Appearance

The results showed that highest mean rank value was obtained at the initial period (23.45) the mean score for first month was 23.40. At the second month score for appearance decreased as 22.80. Least score was obtained at third month 12.35. Mean rank value for initial, first month and second month were on par and appearance score for third month was significantly different.

Colour

Colour of the initial period got the maximum score of 23.70. Score slightly decreased after first month (23.10). At the end of second month score became 22.60 and after the third month score decreased to 12.60, it was the least score obtained. Mean rank got for third month was not on par with initial period, first month and second month.

Flavor

Highest value was obtained for flavor at initial period (26.10) followed by first month (25.20), second month (18.75) and third month (11.95). From the result, score obtained for flavor at third month has significant difference.

Texture

Statistical analysis of the data showed that scores for initial period, first month and second month for texture were not significantly different. Highest value was obtained for initial time (25.10). Least score was obtained after third month (13.65). There was a decrease in initial time to third month of storage.

Taste

Mean rank score for taste in the initial period got the maximum value (22.55) soon followed by first month (21.50). There was a slight decrease in scores obtained by second month (20.20). Least score was obtained after third month (17.75). Statistical analysis revealed that there was no significant difference between the values for tastes during storage up to three months.

Overall acceptability

Table 21 reveals that the overall acceptability of the product. Highest scores were observed at the initial period of time (26.40). Least was at the period of third month (17.81). Mean rank of second month was 21.72 and for the first month score was 23.10. Statistical analysis showed that there was no significant difference between the scores. It means acceptability scores of the health mix (T_{10}) were acceptable up to three months.

4.8. Cost of production

Cost of the developed health mixes were calculated on the basis of the market value of ingredients used for the formulation of health mix, packaging materials and the overhead charges needed for processing each time. The cost of 1 Kg packets of products was calculated and showed in the Table 22.

Table 22. Cost of production

Name of product	Cost / kg product (Rs)
Health mix (T_4)	324
Health mix (T_{10})	344

DISCUSSION

DISCUSSION

The results of the present investigation entitled "Development and quality evaluation of Geriatric health mix" is discussed under the following headings.

- Selection of base materials and other ingredients
- Standardization process of the health mix
- Acceptability trials of the health mix
- Standardization of recipes and consumer acceptability of the product
- Quality evaluation of geriatric health mix
- Shelf life study
- Cost of production

Selection of base materials and other ingredients

Diet plays an important role in preventing disease in elderly. (Kazemi *et al.,* 2011). To prevent elderly persons from becoming under-nourished and to reduce the risk of non-communicable diseases, their meals should have a balanced energy and protein distribution in terms of macro nutrients. It is appropriate to have cereal legume combination in their diets to achieve nutritional adequacy (WHO, 2002).

In the present study Wheat rava, Ragi, Barley and Oats were selected as base materials. Each of the raw materials were roasted, powdered and sieved.

Heat-processing of the whole millet inactivates lipid enzymes, microorganisms and germs. Therefore, heat processing helps to extended the storage life of the product. However, there were no significant flavor changes occurs due to heat-processing (Ramasri, 2013).

Dehydrated vegetables, dehydrated fruit bits, skimmed milk powder and food adjunct were the other selected ingredients. Dehydrated vegetables such as onions, beans and carrot were added. Dehydrated fruit bits such as dried pine apple, dates and dried amla in honey were crushed and added.

Finger millet is a minor millet and is important staple food in some parts of India among the low income groups. Finger millet contain high amount of protein, iron, calcium, phosphorus, fiber and vitamin. Compared to other cereals calcium content is higher in finger millet (0.38%). Deficiency in calcium leads to bone and teeth disorders which can be overcome to a great extent by introducing finger millet in our daily diets (Gopalan et al., 2010).

According to Pragya and Rita (2012), carbohydrate and protein content of finger millet had been reported to be in the range of 72 to 79.5 per cent and 5.6 to 12.70 per cent. Total ash content was higher in finger millet, it has been found to be nearly 1.7 to 4.13 per cent in finger millet.

Priyanka and Ashwini (2013), developed a mix which was a finger millet based convenient mixes. The mixes were formulated with 60 percent refined finger millet flour, wheat flour, soy flour, dry gluten powder in a ratio of 24:10:6 respectively. Two recipes were prepared (chapatti and poori) with these mixes. Sensory evaluation and nutrient composition was conducted. Finger millet based convenience mixes revealed higher calcium and iron levels. Thus the study revealed that finger millet can be used as convenience mixes and products to enhances nutritive value.

Tripathi and Mishra (2005), reported that soy fortification enhances the nutritional and functional properties of food products. Soy protein help in growth and development. The ratio of poly unsaturated fatty acid to saturated fatty acid present in the soya is 82:18 which is good to lower the blood cholesterol level. And it is also good in antioxidant property.

Another study conducted by Salve *et al.*, (2011) reported that Supplementary foods formulated using wheat flour, soyabean flour and chick pea flour and 10 percent skimmed milk powder contained higher amounts of protein and other nutrients. Result showed that soya flour fortification increased the amount of protein from 16.2 to 21.1 percent. Studies confirm that soya flour fortification was the best and good because it is rich in protein with good product acceptability.

According to Priyanka and Ashwini (2013) the fortification of soy flour with finger millet increased the protein content of food products.

Barley has high amounts of soluble fibre and therefore addition of barley to a healthy diet may be effective in lowering total and LDL cholesterol (Behall *et al.*, 2004).

Consumers of oats had a significantly higher daily intake of fibre than those who did not use oats. Two thirds of celiac disease patients preferred to use oats in their daily diets (Kaukinen *et al.*, 2013).

The fruits and vegetables provide good nutritional benefits. Fruits and vegetables are sustainable dietary source of vitamins, trace elements and other bioactive compounds (Lohekar, 2014).

Fibre intake seems to be important in the elderly which necessitates the intake of fruits and vegetables in the daily diet (Donini *et al.*, 2009).

Twenty-one standard amino acids are present in skimmed milk powder and it is also high in proteins, and minerals like calcium and phosphorus along with water soluble vitamins (Lohekar, 2014).

A study conducted by Take *et al.*, (2012) to develop a sapota-papaya fruit bar with the aim of enhancing its nutritional value by fortifying with skimmed milk powder. The study reported that the protein content of sapota-papaya bar was increased from 1.17 percent to 1.85 percent by the addition of skimmed milk powder and in the case of fruit bar without addition skim milk powder, the protein content was found to be 0.87 percent. Also the amount of energy was higher in the sapota-papaya bar, which was fortified with skimmed milk powder.

Standardization process of the health mix

Standardization plays an important role in product development which helps in the growth of food industries. According to Poduval (2002), one of the fore most purpose of standardization is to facilitate the movement of material and products through all stages of production in any industrial activity, starting from the raw material to the finished products, then to the dealer and finally to the retailers and consumers.

Many processed foods are available in the market today. Today's consumer prefers dehydrated products. So dehydrated products have gained great popularity in the recent years. In this context, there is a scope to develop health mixes with prolonged shelf life (Gopalan *et al.*, 2009).

In the present study proportions of base materials proposed in the health mix were 60 gram and other ingredients were 40 grams. Base materials and other ingredients were dried separately and blended to obtain various formulations. proportion of ingredients selected in the formulation of health mixes were optimized based on the calorie and protein adequacy.

Two groups of combinations were proposed. Each group included five treatments. Best three treatments of each group were selected based on computed energy and NDP CAL percent. In the first group the NDP CAL percent of T_1, T_4 and T_5 was higher than the other treatments. But energy was lower in T_1 and T_5 because of the difference in combinations of the ingredients. So T_1, T_4 and T_5, were selected as best combinations.

In the second group of treatments energy varied from 309.93 to 322.01 KCals. NDP CAL percent of T_6, T_9 and T_{10} were higher than other treatments. So T_6, T_9 and T_{10} were selected as best combinations. Fig 1 to 4 depicts the energy and NDP CAL % of two groups.

Acceptability trials of the health mix

Sensory evaluation is a scientific method used to measure and analyze the responses of the product through the senses of sight, smell, touch, taste and hearing (Stone and Sidel, 2002).

According to Potter (2009), the important parameter of any food is its sensory characteristics. The quality of a food is based on the combination of sensory parameters (appearance, colour, texture, flavor and taste) that determine the acceptability of the food product. Nutrient value, microbiological safety, cost and convenience were determined for food quality.

Development of nutritious and organoleptically acceptable product with locally available foods will prevent micronutrient malnutrition (Nambiar and Parnami, 2005).

Sensory evaluation of first group of treatments

Appearance

Appearance is the first impression of a food. The highest mean rank value for appearance was T_4 (25.50), which was the combination of ragi, oats, soya, dehydrated

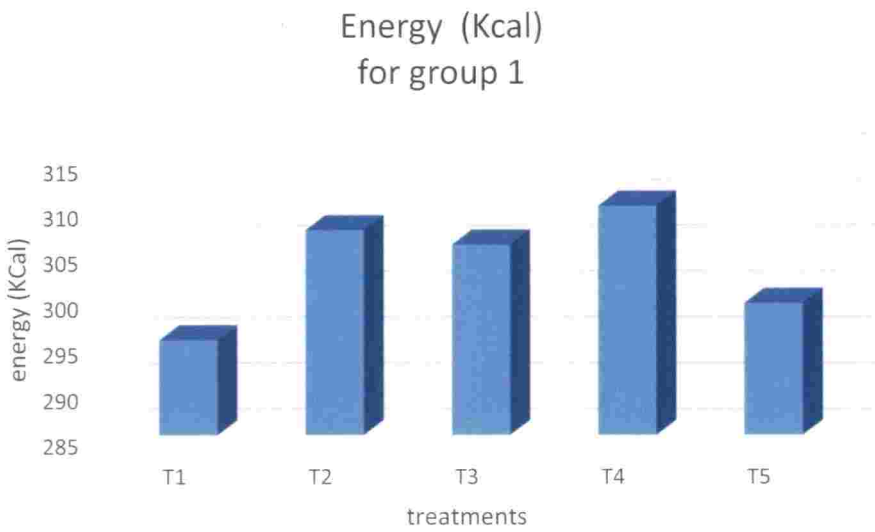

Fig. 1. Energy (Kcal) for group 1

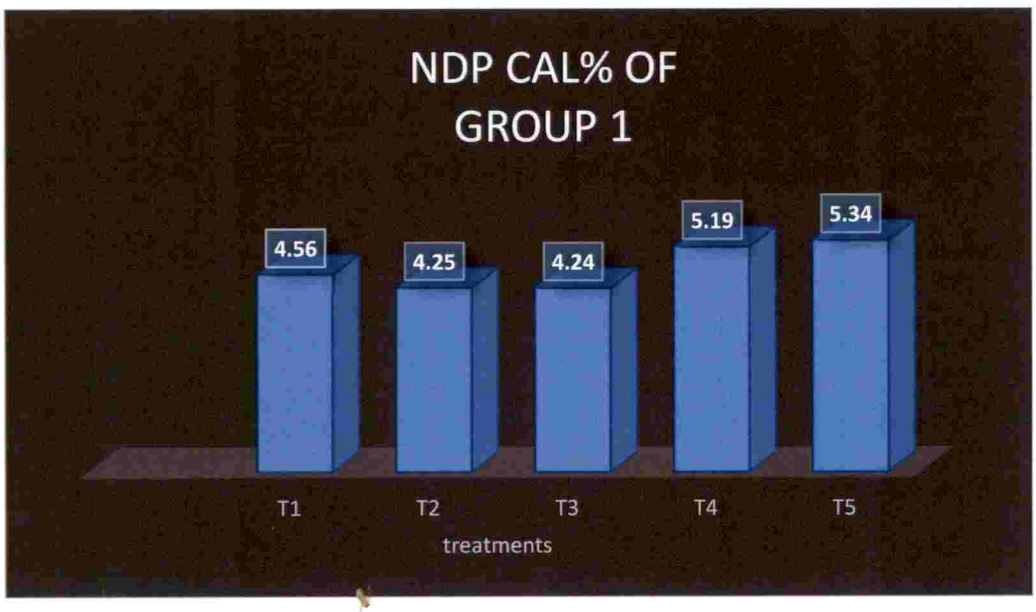

Fig.2. NDP CAL % of group 1

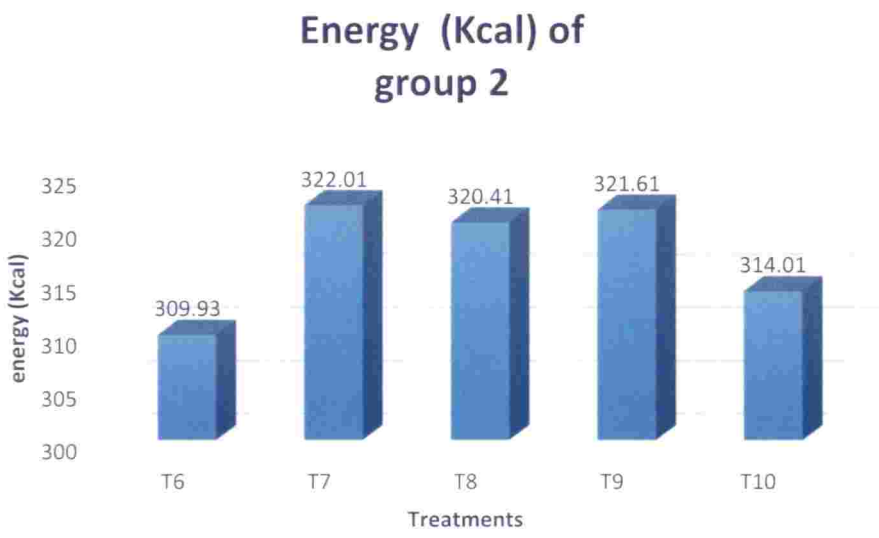

Fig 3. Energy (Kcal) for group 2

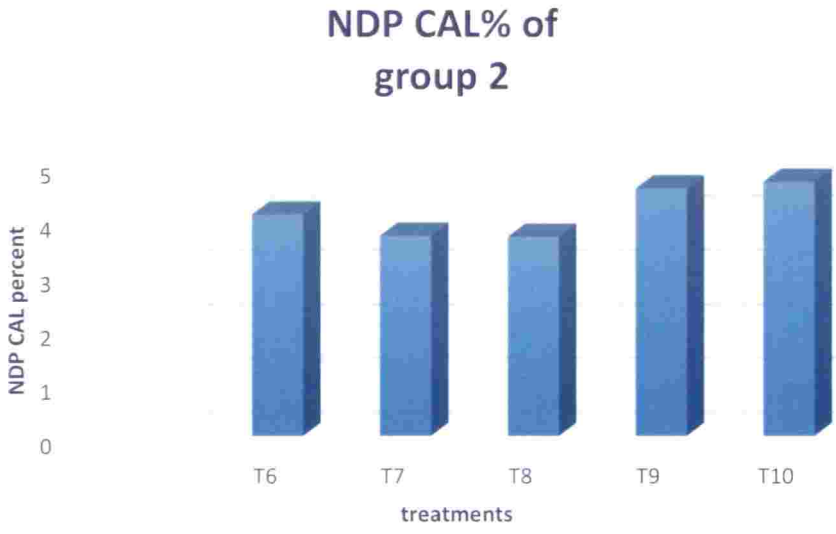

Fig. 4. NDP CAL % for group 2

vegetables and skimmed milk powder. The score of T_4 was observed to be significantly higher than other two treatments.

Colour

According to Dorko and Penfield (1993), acceptability of foods are based on colours too. Colour is one of the major attributes used to judge the overall acceptability of a food. T_4 was noted to get the highest mean rank score (20.15). While T_1 recorded lowest mean rank score.

Flavor

Highest mean rank was obtained by T_4 (18.95) and least value was obtained by T_1 which was significantly different from T_4 and T_5

Texture

Texture contributes to the physical property of a food stuff. T_4 revealed higher score of 24.70 and lowest score was secured by T_5 and T_1.

Taste

Taste is one of the important attributes for the acceptability of a food products. Highest score for taste was observed in T_4 (25.15) and least was obtained to T_5, followed by T_1. The three scores were significantly different from each other.

Overall acceptability

T_4 obtained the highest acceptability score of 24.60 and therefore T_4 had the highest preference followed by T_5 and T_1. The three scores of different formulations were statistically different. Fig 5 depicts the acceptability of the health mix (group 1).

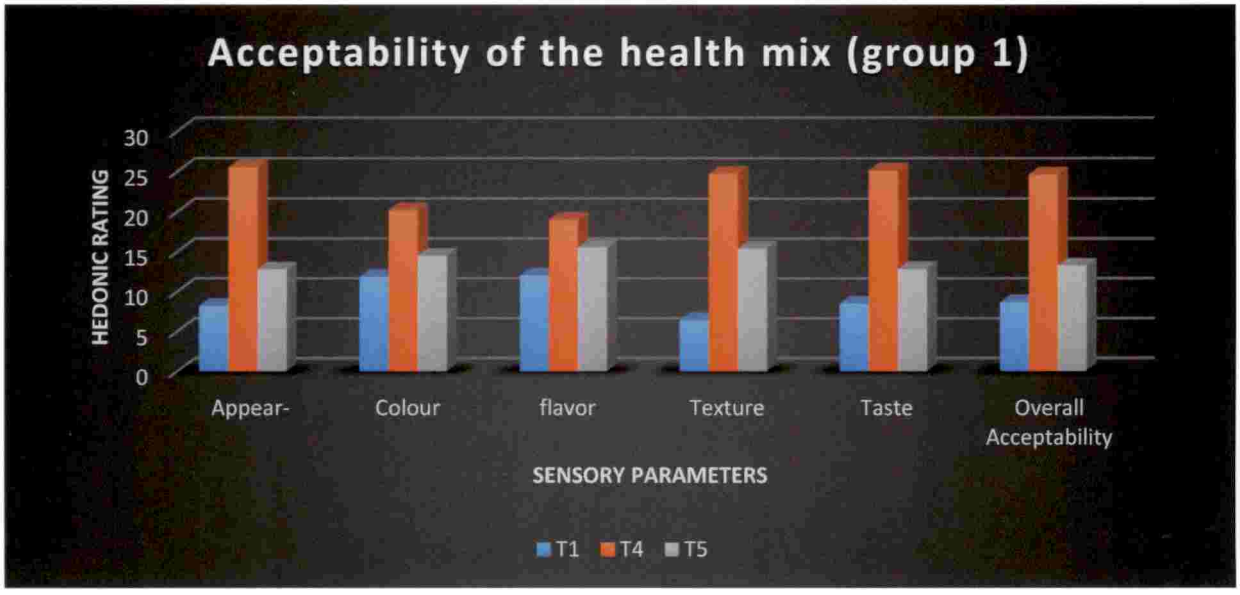

Fig. 5. Acceptability of the health mix (group 1)

Sensory evaluation of second group of treatments

Appearance

In the case of appearance T_{10} scored maximum mean rank value (22.05). T6 got the lowest mean rank value. The mean rank values obtained for the treatments were found to be significantly different.

Colour

Colour is very important criteria for consumer acceptance of food products. T_{10} recorded the highest mean rank value (18.15). Least mean rank value was obtained for T_6. The scores were significantly different from each other.

Flavor

The maximum mean score for flavor was noted for T_{10} (18.60) while least mean rank value was obtained for T_6. T_6 was significantly different with T_9 and T_{10}.

Texture

T_{10} got the highest mean rank value (24.75) and T_6 got the least mean rank value for this parameter. The scores obtained were significantly different.

Taste

The three formulations varied in their scores, T_{10} scored the maximum mean rank value (24.60) lowest score was secured by T_6 and the values obtained were significantly different.

Overall acceptability

Results revealed that T_{10} obtained the highest mean rank value (25.10) in overall acceptability. Second position was secured by T_9 and third position was obtained by T_6. So T_{10} was selected as best formulation from the second group. Fig 6 depicts the acceptability of the health mix (group 2).

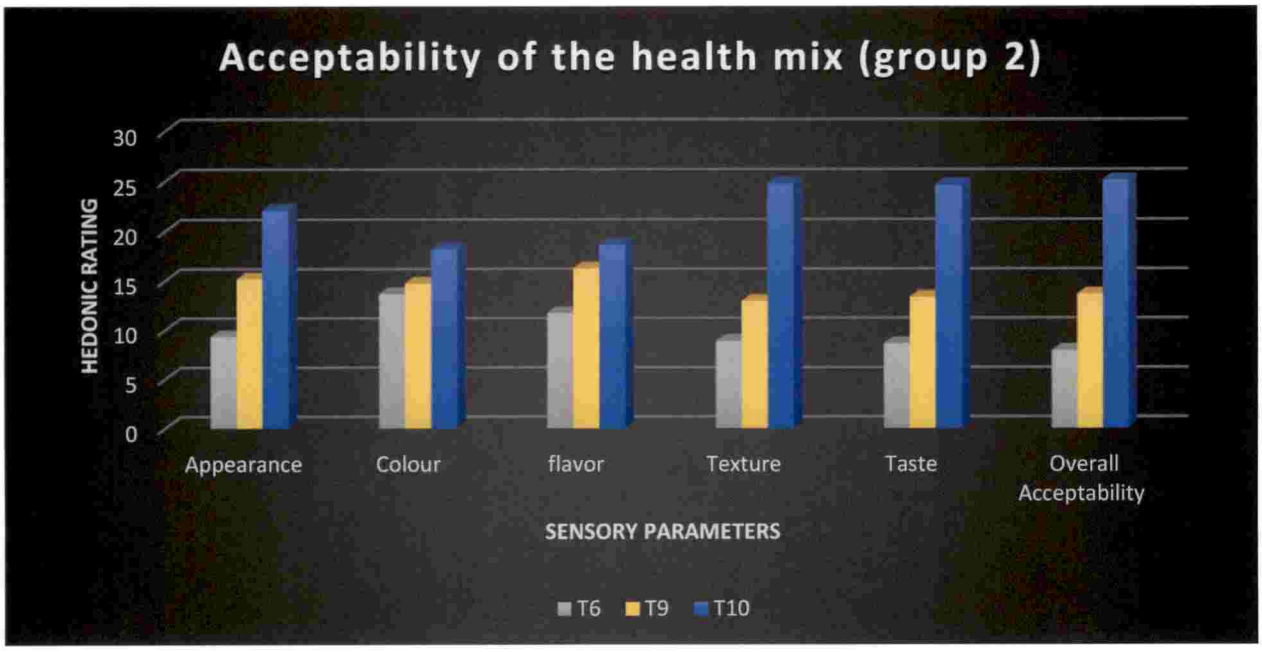

Fig 6. Acceptability of the health mix (group 2)

Standardization of recipes and consumer acceptability of the product

Today consumers have good ideas about food safety and quality. A consumer measures the quality of a food using visible features. And also they have the awareness about the microbial safety and nutritive value (Taeman, 2000).

According to Anvita *et al.,* (1993) consumers are very much aware about the sensory quality associated with a given processed food. Consumer acceptability of a food product is conducted on a large number of consumers (Watts *et al.*, 1989).

According to Sabapathy and Bawa (2007), the main objective of the food industry is to supply the consumer with a variety of food products manufactured to ensure maximum quality stability and safety.

Consumer acceptance is driven by product quality therefore, it is important to measure the sensory characteristics of the newly developed products to ensure that they ultimately meet consumer's expectations (Chapman *et al.*, 2001)

The consumer demands food, that will remain fresh for long time, will be easy to handle, safe and healthy and also have an environmental friendly packaging (Pandey *et al.,* 2005)

Five types of dishes were prepared with both formulations (T_4 and T_{10}). The prepared dishes were Elayappam, Oratty, Dosa, Porridge and Steamed cake. Hedonic rating of recipes were done. Acceptability of the developed health mix dishes were assessed among 30 elderly people. On analysis the highest mean rank values were scored by the dish Elayappam. 35.96 for T_4 and 28.88 for T_{10}. Oratty obtained the second highest mean rank value 33.93 for T_4 and 28.58 for T_{10}. Dosa scored the third position, followed by porridge and steamed cake. The scores obtained by T_4 and T_{10} for Elayappam, oratty, dosa, porridge and steamed cake were significantly different. Fig 7 depicts the consumer acceptability of the product.

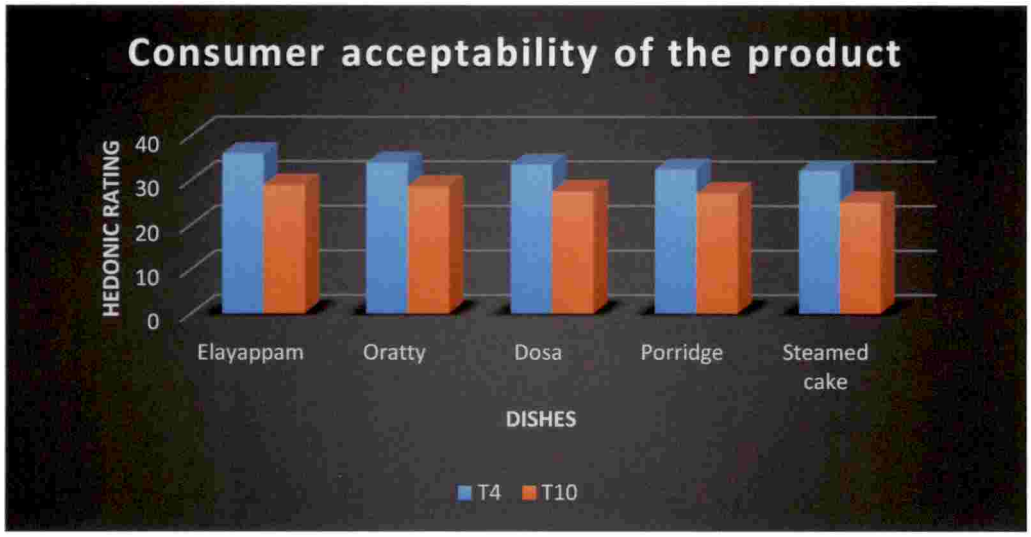

Fig 7. Consumer acceptability of the product

Determination of portion size

Portion size of the health mix was determined using food exchange list for easy adoption. Energy requirement for sedentary adult man is 1883 Kcal and that for sedentary woman is 1782 Kcal. one portion of health mix was 200 grams. As this would meet one third requirement of the RDA. This amount could be had as one meal or two meals for this group.

Quality evaluation of geriatric health mix

Food quality system is related to processing conditions, product characteristics, product performance, and consumer requirements. All these features are considered for studying or optimizing the overall quality of food products (Peri, 2006).

Food quality is the determination of nutrient value, microbiological safety, cost and convenience (Potter, 2009).

It has been emphasized that the most appropriate and sustainable approach for correcting nutritional deficiencies is dietary improvement through a better choice of foods with improved quality and greater variety (Scrimshaw, 1994)

In the present study, the developed health mixes were assessed for their functional qualities, chemical composition, nutritional quality and shelf stability.

Functional qualities

The functional quality of a food product determines the overall characteristics of the food during production, processing, storage and consumption (Agunbiade *et al.*, 2006). Functional qualities help in the qualitative assessment and acceptability of any product. The functional qualities like yield ratio and bulk density were studied.

Yield ratio

The yield ratio of ingredients used in the formulation of health mix (T_4) comprising of ragi, oats, soya, dehydrated vegetables and skimmed milk powder and in the case of T_{10} comprising of ragi, barley, soya, dehydrated fruit bits and skimmed milk powder were calculated. The data revealed that higher yield ratio was recorded for T_{10} (0.83). Lesser value was obtained for T_4 (0.45). The values showed significant difference statistically.

Bulk density

According to Induruwa *et al.,* (2009) one of the important simple physical parameter of food quality is bulk density. Bulk density gives weight of substances in unit volume which influence the packaging requirement of a product and the transportation costs (Ranganna,2001).

The results show that T_{10} had higher bulk density (0.66) and lesser value obtained for T_4 (0.55). The two combinations were significantly different in bulk density. Fig 8 depicts the yield ratio and bulk density of the health mix.

Kamara *et al.,* (2009) conducted a study with two varieties of foxtail millet, defatted millet flour white and defatted millet flour yellow which had bulk densities of 0.27 and 0.23 respectively.

High bulk density is a disadvantage for the formulation of weaning foods or health mixes therefore low density is required (Onimawo and Egbuken, 2002).

Cooking characteristics

Nagarajan (2000), opined that, food products cooked using less energy was more popular among consumers. Saving time, labour and fuel play an important role among consumers.

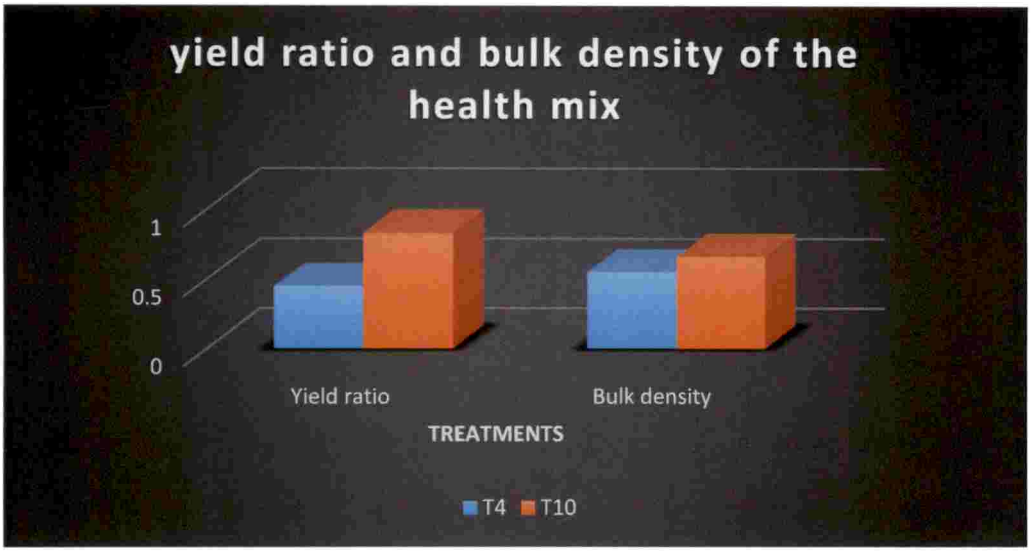

Fig 8. Yield ratio and Bulk density of the health mix

According to Donelly and Busta (2001), cooking time was calculated from the time of adding the product to boiled water till it got completely cooked. In the present study 20 gram of health mix and 250 ml of water took 10 minutes for cooking and the yield was 40 gram of product.

Nutrient composition in health mix

According to Kalia and Sood (1996), degree of acceptability of a food product by a consumer is greatly determined by its nutritional quality.

Potty and Mully (2000), stated that nutrients are invisible chemicals which help to keep the body healthy. Nutrient composition of health mixes were determined with respect to carbohydrate (g), protein (g), fibre (g) and total minerals (mg).

Calories

The amount of energy in a food item is measured in calories. Energy value depends upon the amount of carbohydrate, protein and fat present in food items.

Statistical analysis showed that energy value of T_4 was higher (310.03Kcal), when compared with T_{10} (309.72Kcal) and both values were statistically different. Fig 10 depicts the energy content of the health mix.

Carbohydrate

Results revealed that the amount of carbohydrate was higher in T_{10} (54.21g/100g) than in T_4 (54.07g/100g). There was significant difference between carbohydrate values of T_4 and T_{10}. Fig 9 depicts the carbohydrate and protein content of the health mix.

Ahmad *et al.,* (2013) conducted a study at Aligarh on development, quality evaluation and storage stability of a weaning food. This product revealed the carbohydrate content as 17.24 -17.58 per cent.

Itagi and Singh (2012), conducted a study based on multigrain composite mixes prepared from different cereals, legumes, millets, nuts along with condiments using different processes. Multigrain composite mixes had 56 to 61 percent carbohydrate.

Ramasri, (2013), conducted a study based on the feasibility of incorporation of minor millets in the preparation of a health mix and reported that the carbohydrate content ranged between 74.99g to 80.56g/100g.

Compaore *et.al.,* (2011) conducted a study on three developed formulas with cereals and millets mixed with predetermined portions of seeds and pulps in order to obtain enriched flour. The carbohydrate content ranged between 64.5 percent to 70.81 percent.

Protein

Protein is found throughout the body. They are the building blocks of life. Protein is important to replace worn out cells, transport substances throughout the body, and also aid in growth and repair. Higher protein consumption helps to control body fat deposition.

Protein value of T_4 (18.80g/100g) was higher than T_{10} (17.98g/100g). There was significant difference between the mean values.

Ramasri (2013), conducted a study on health mixes the rang of protein content of the health mixes were 9.57g to 16.72g/100g. Composite mixes were developed by Kurahatti in 2010 using cereals, pulses, oilseed and green leafy vegetables which contained protein to the level of 14.85g/100g.

Srilatha (2015), conducted a study on health mixes and reported that range of protein content of the mixes was about 12 g– 17g/100g

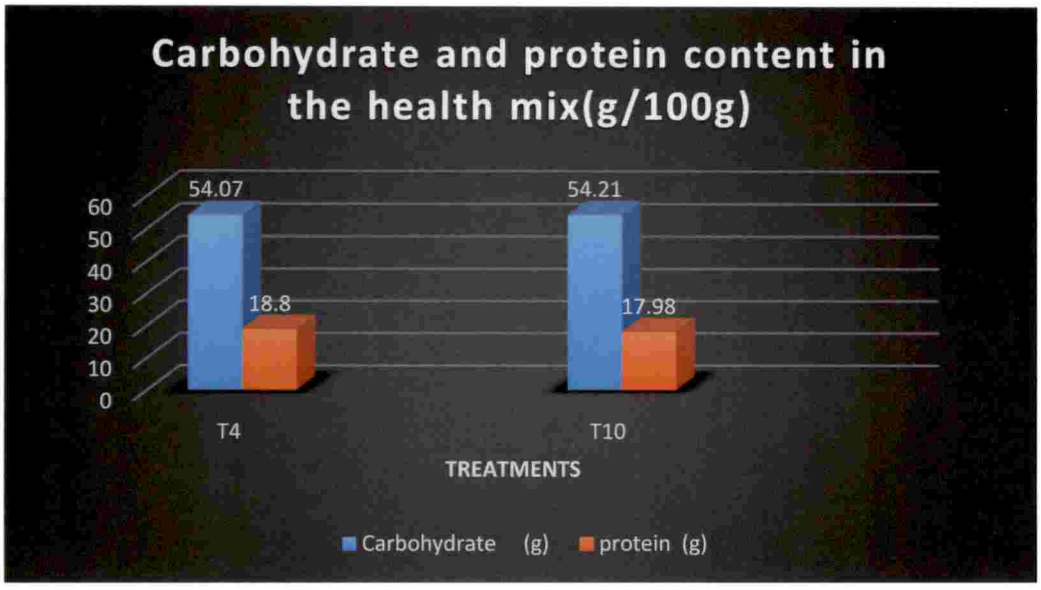

Fig 9. Carbohydrate and protein content in the health mix

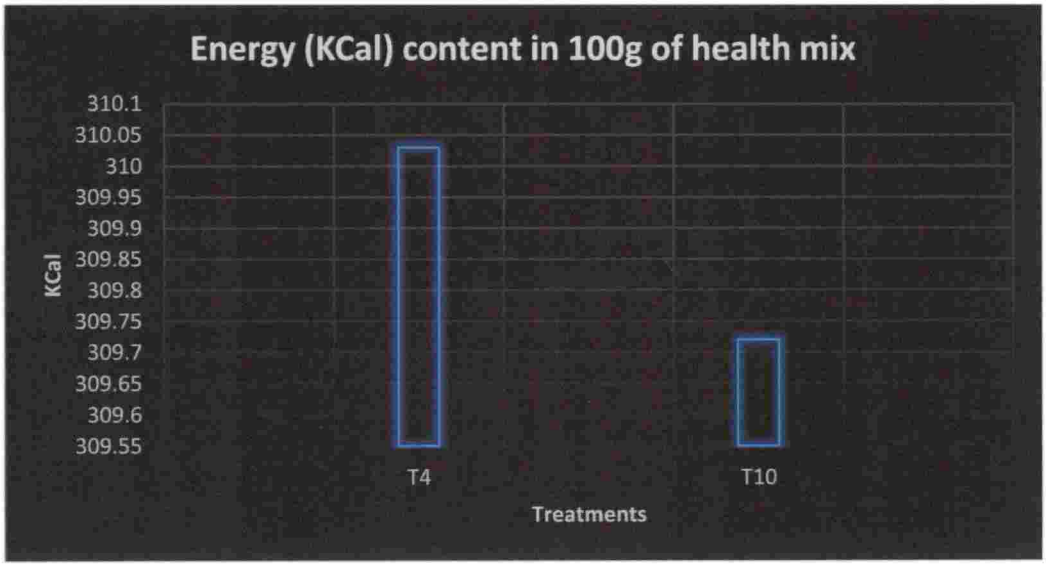

Fig 10. Energy (Kcal) content in 100 g of health mix

Ahmad *et al.*, in 2013 conducted study at Aligarh on Development, quality evaluation and storage stability of weaning foods using different combinations of rice flour, gram flour papaya powder and milk powder. The nutritional assessment of the products indicated that protein content was between 18.42-19.02 per cent.

Itagi and Singh (2012), conducted a study based on multigrain composite mixes prepared from different cereals, legumes, millets and nuts along with condiments by different processes. Multigrain composite mixes had protein in the range of 9 to 13 percent.

Fibre

Fiber content of the developed health mixes were found to be higher in T_{10} (7.87%) and less in T_4 (7.50%). There existed a significant difference between T_{10} and T_4. Shaila (2010), conducted a study on composite mixes. The fiber content of the mix was found to be 6.45%. Fig 11 depicts the fibre content of the health mix.

Iron content of developed health mix

Iron helps our muscles to store and use oxygen. Iron has a role in creating energy from nutrients. It helps in the transmission of nerve impulses. It is also essential for blood production. Iron plays an important role in immune system.

In the present study, iron content of developed health mixes were 5.08mg/100g for T_4 (highest mean rank score) Lesser amount of iron was present in T_{10} (4.43mg/100g). The mean rank scores were significantly different.

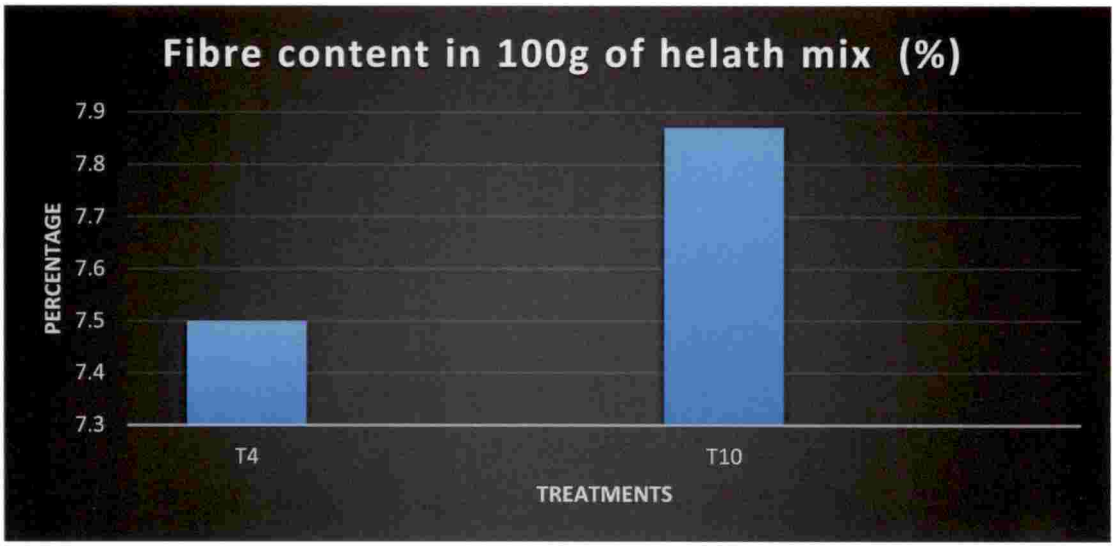

Fig 11. Fibre content in 100g of health mix

Calcium content of developed health mix

Calcium is the most abundant mineral found in the body. Teeth and bones contain more calcium. Nerve cells, blood and other body fluids contain rest of the calcium. Maintaining good levels of calcium in the body helps to prevent osteoporosis.

In the present investigation, calcium content in the developed health mixes were 272.52 mg/100g for T_4 and 270.45mg/100g for T_{10}. Samples showed significant statistical difference. Fig 12 and 13 depicts iron and calcium content of the health mix.

Sodium content of developed health mix

Sodium helps to control fluid balance, helps to send nerve impulses that affect muscle function. It controls blood pressure and blood volume.

The results revealed that higher value of sodium was show by T_{10} (6.37mg/100g). Lower value was show by T_4 (5.88 mg/100g). The two values had significant difference.

Potassium content of health mix

Potassium is an essential body mineral. Body needs potassium to function normally. It is important for the cellular and electric function. It plays an important role in heart, skeletal and smooth muscle contraction. It also helps in digestive function.

The results revealed that the highest mean rank value for potassium was recorded for T_{10} (174.34 mg/ 100g) and least was recorded for T_4 (172.54 mg/100g). statistically the treatments were found to be significantly different. Fig 14 and 15 depicts potassium and sodium content of the health mix.

Chemical Composition

According to Sharma (2006), study on chemical composition of food products is helpful to determine the quality of food. Lesser or higher amount of some chemicals should affect the acceptability or non-acceptability of the food products.

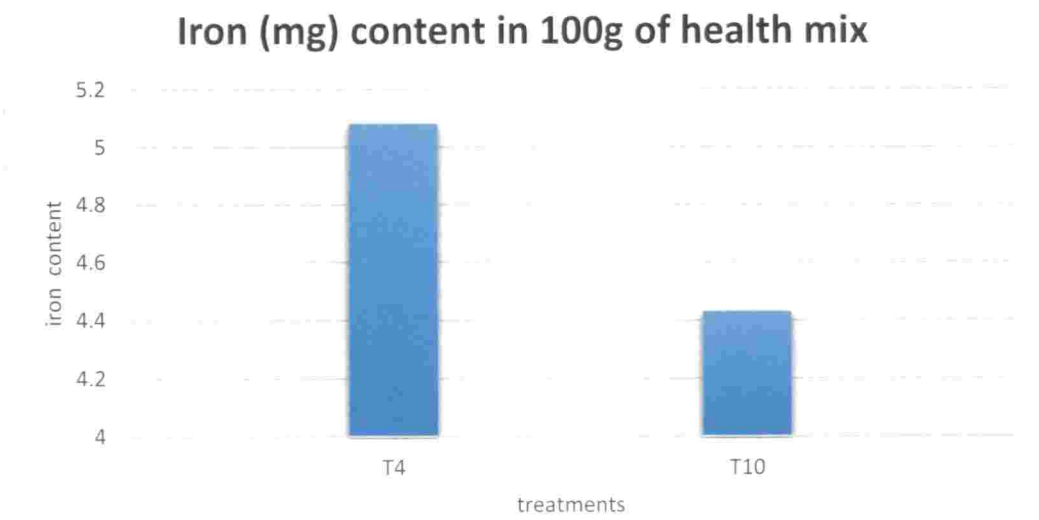

Fig 12. Iron (mg) content in 100g of health mix

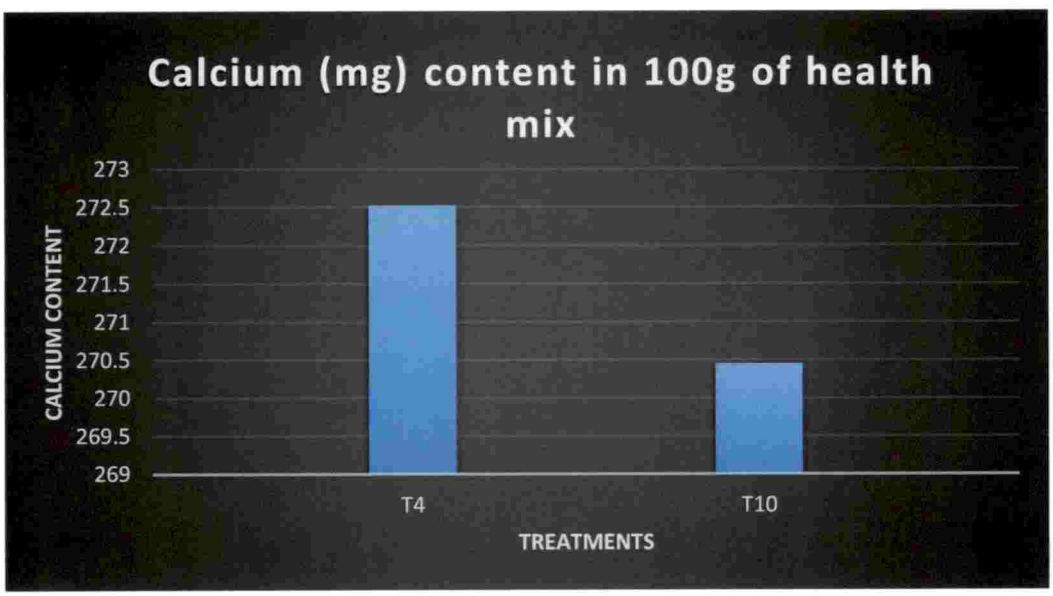

Fig 13. Calcium(mg) content in 100g of health mix

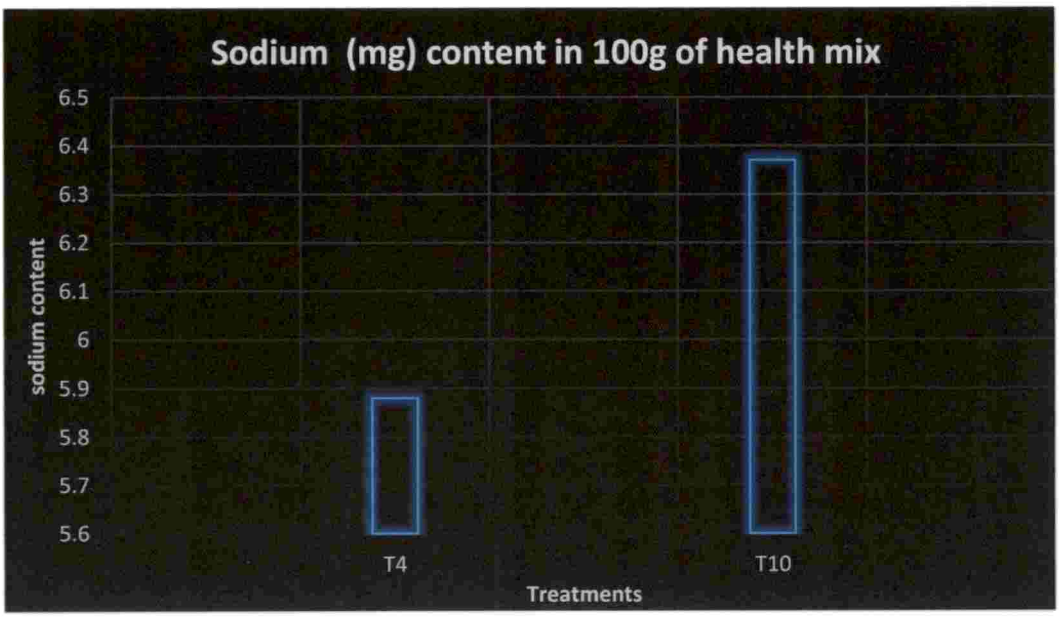

Fig 14. Sodium (mg) content in 100g of health mix

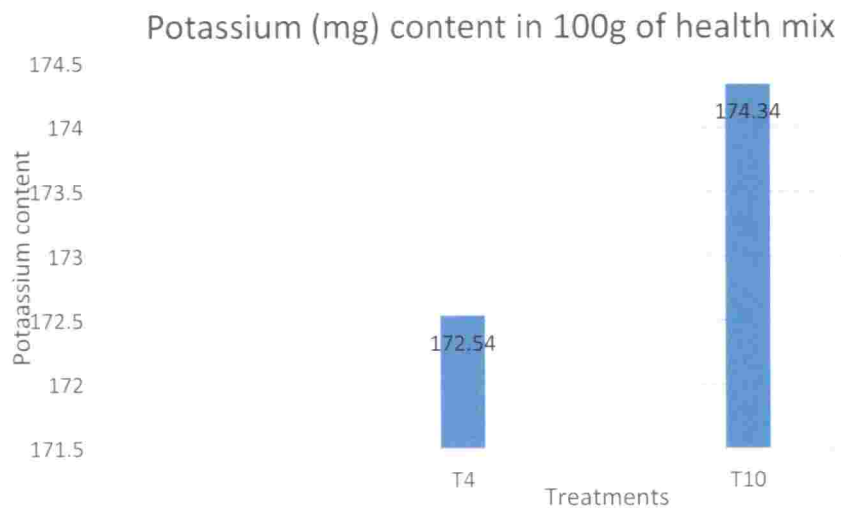

Fig 15. Potassium (mg) content in 100g of health mix

Chemical composition of developed health mix was analyzed for moisture (%), acidity (%), total ash (mg) and peroxide value (meq/kg).

Moisture content of the health mix

Moisture content of food affects the quality of a food product. It also affects the physical and nutritional composition of the developed products. As per the FSSAI specifications moisture content of dehydrated products should be between 5-7 percent.

The moisture content in the developed health mixes was found to be 3.04% in T10 and in the case of T_4 it was 2.60%. So T_{10} had higher moisture content. They were significantly different. Fig 16 depicts the moisture content of the health mix.

Ramasri (2013), conducted a study on health mixes. Her study revealed that the moisture content of the health mixes were in the range of 8.24 percent to 8.6 percent.

Itagi and Singh (2012), conducted a study based on multigrain composite mixes prepared from different cereals, legumes, millets, nuts along with condiments by different processes. Multigrain composite mixes had 10 – 12% moisture.

Acidity of developed health mix

Acidity is because of the free hydrogen ions present in the foods leads to the sour taste. The present investigation shows that highest acidity value of formulated health mix was found at T_{10} (0.29%). The least value was 0.20 % for T_4. The values were not significant. Fig 17 depicts the acidity content of the health mix.

Total ash content in the health mix

Ash content of the food means the inorganic substance present after the organic matter is burnt away. Based on the present observation, the highest mean score for total ash content in the health mix was obtained by T_{10} (2.88) and least was scored for T_4

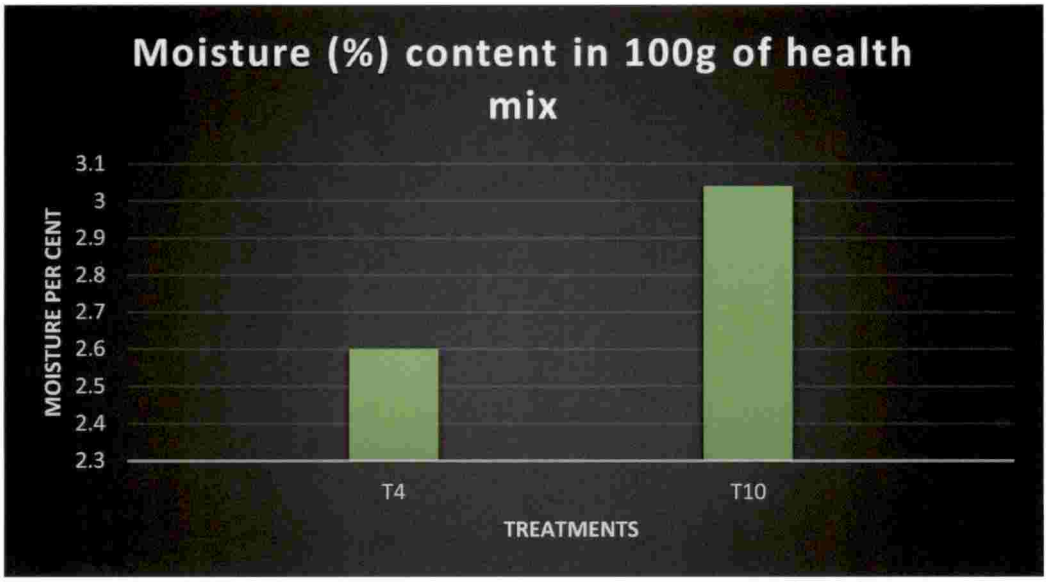

Fig 16. Moisture (%) content in 100 g of health mix

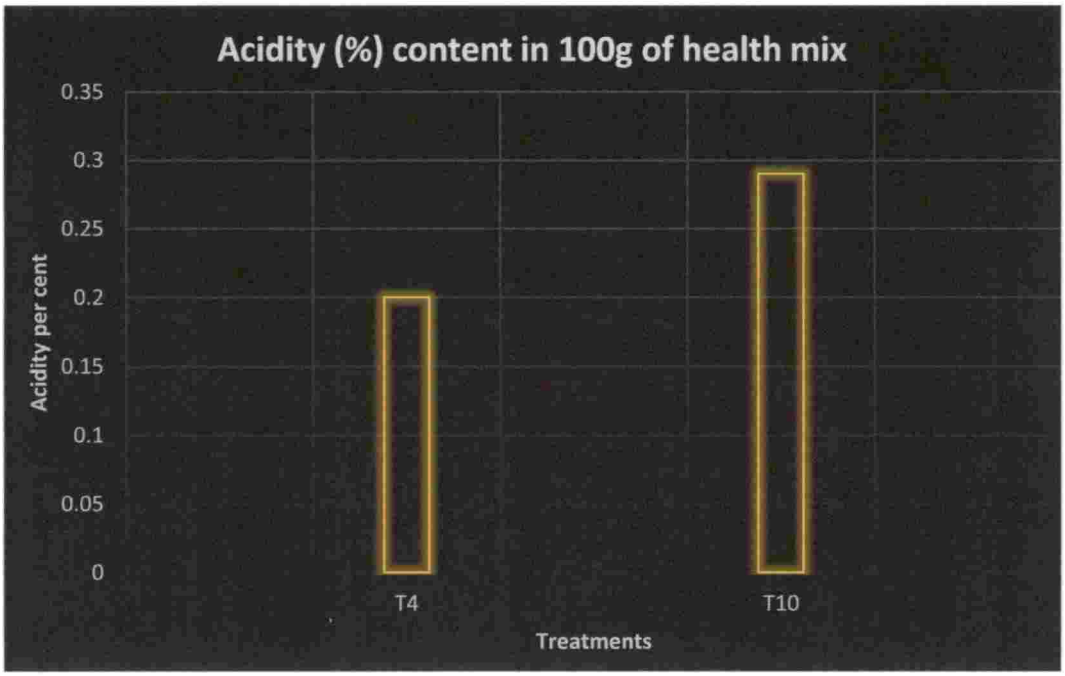

Fig 17. Acidity (%) content in 100g of health mix

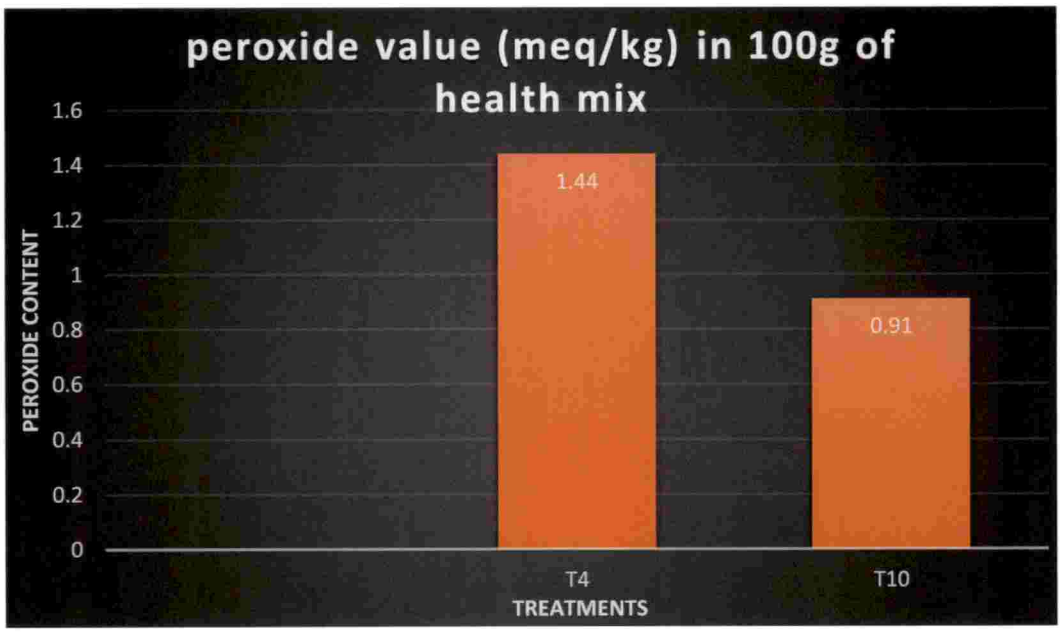

Fig 18. Peroxide value (meq/ kg) in 100g of health mix

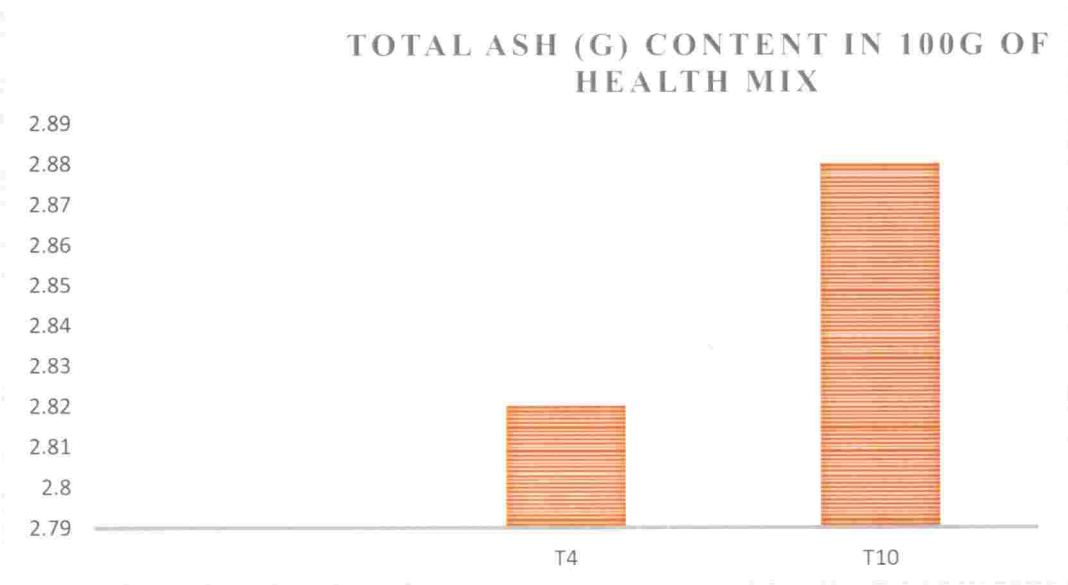

Fig 19. Total ash (g) content in 100 g of health mix

(2.82). Statistically T_4 and T_{10} were found to be significantly different. Fig 19 depicts the total ash content of the health mix.

A similar result was noted by Adesokan *et al.,* (2011) on soybean fortified composite Ogi (A Nigerian fermented cereal gruel). Four formulations were tried and their ash content was found to be 2.72g /100g, 2.63g/100g, 2.44g/100g and 1.34g/ 100g respectively.

Ramasri (2013), conducted a study based on health mix. Her study revealed that ash content in the health mix was 1.18g/100g

Srilatha (2015), conducted a study based on development and acceptability of health mixes and observed that ash content of the health mix was 3.02g/100g.

Itagi and Singh (2012), conducted a study based on multigrain composite mixes prepared from different cereals, legumes, millets and nuts along with condiments using different process method. Multigrain composite mixes had 2 to 3% ash.

Peroxide content in the health mix

Peroxide value is a measure of the concentration of the fatty acid hydroperoxides, which is the first product of lipid oxidation (Gyesley, 1991). In the present investigation the highest mean rank score for peroxide value was found to be 1.44meq/kg for T_4. The lower value was obtained for T_{10} (0.91meq/kg). Fig 18 depicts peroxide content of the health mix.

Shelf life stability of health mix

According to Kumar (2001), shelf life is the duration of time that a material in a container will remain in a saleable or acceptable condition under specified condition of storage.

Food products need good storage stability and are free from microbial contamination over a period of time. So packing the foods with the right material can definitely increase the shelf life of the products. Use of low cost packaging material may be useful in increasing the keeping quality without addition of additives (Shemshad *et al.,* 2006).

Shelf life depends on a multiplicity of variables and their changes, including the product, the environmental conditions, and the packaging. Depending on the product and its intended application, shelf life may be dictated by microbiology, biochemistry, enzymology or physical effects (Brody, 2003).

The shelf life quality of developed health mixes were analyzed by assessing the moisture content, acidity, peroxide value, microbial growth and acceptability of health mix up to a period of three months.

Peroxide value of stored health mix

Development of peroxides leads to undesirable flavour (Sharma, 2006). In the present study peroxide value increased from initial period to third month. The peroxide content of stored health mixes in initial level was 1.47meq/kg for T_4 and 0.92meq/kg for T_{10}. The scores obtained for initial and first month were significantly different for T_4 and in the case of T_{10} it was significant. Result of storage after third month revealed that peroxide value had increased up to 2.01meq/kg for T_4 and 1.44meq/kg for T_{10}. Highest mean rank score was 2.01meq/kg for T_4 at the end of third month. Fig 20 depicts peroxide content of stored health mixes.

Krokida *et al* (2001), reported that peroxide value increases during storage. Though peroxide value increased during storage, the increase was within the permissible limits of 10meq/kg fat (Shaila, 2010).

Moisture content in stored health mix

Moisture content of the stored health mixes in laminate pouches were analyzed up to three months.

Initial moisture content of T_4 was 2.03 per cent. The results revealed that, there was an increase in moisture content from initial to third month, but it was found to be with in the limit. The mean score values were found to be significantly different. Fig 21 depicts moisture content of stored health mixes.

As for T_{10} initial moisture content was 3.63 per cent. At the end of first month it ranged to 4.73 per cent. At the end of third month moisture content found to increased 5.83 percent. There was increase in moisture content from initial to third month. The values were significantly different. Moisture content of T_{10} was higher than T_4.

Nasir *et al.*, (2003) conducted a study on different flour treatments. He found that the storage intervals and treatments were affected by the moisture content of the product.

Karuppasamy *et al.*, (2010), developed millet based convenience mix and evaluated. The studies revealed that the moisture content due to storage was increased.

Acidity content in the stored health mix

Acidity of T_4 during the initial period was recorded to be 0.34%. The value increased at monthly intervals up to three months. The values of initial and first month were significant. The values of second and third month were significantly different. Higher values were obtained after the third month which was 0.42 percent.

Data revealed that acidity of T_{10} in the initial period was 0.22 per cent. which increased steadily up to three months. The values of initial period and first month were on par and the score of third month was on par with second month score.

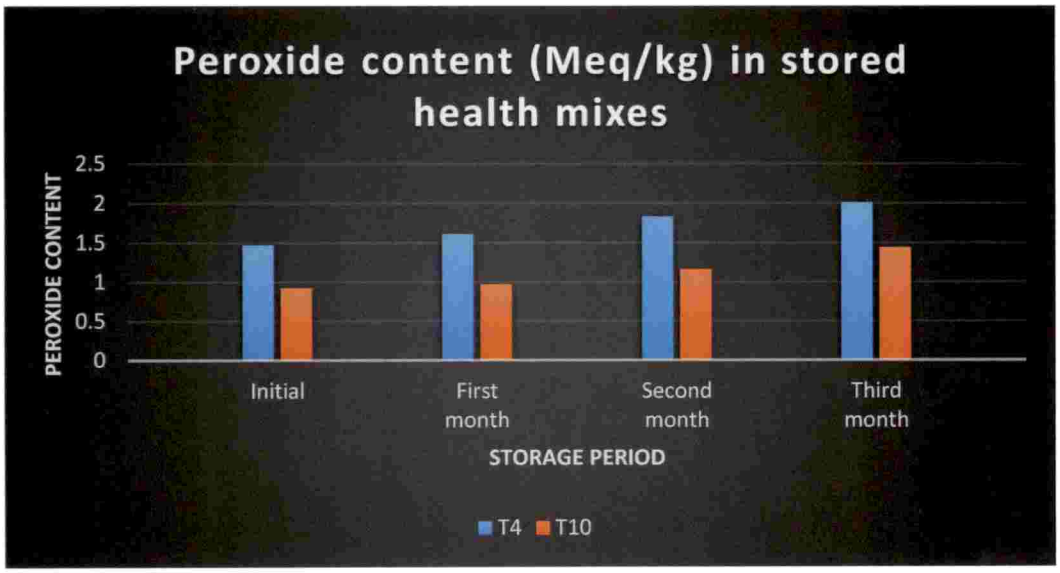

Fig 20. Peroxide (meq/ kg) content in stored health mixes

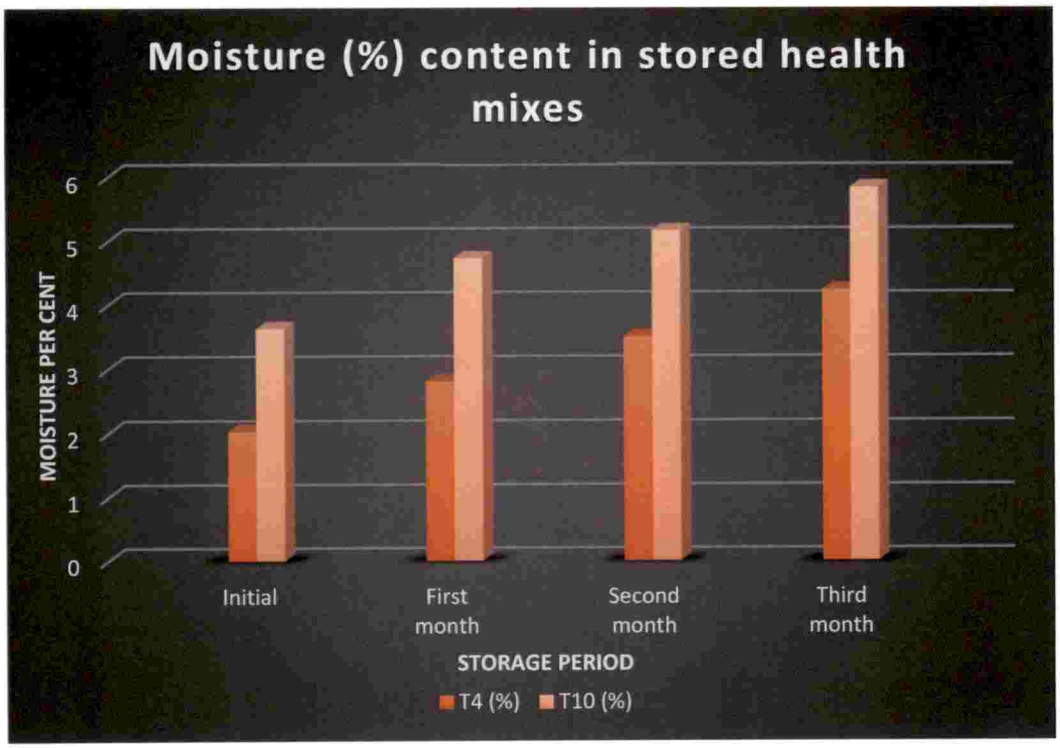

Fig 21. Moisture (%) content in stored health mixes

Microbial study

Determination of microbial quality is one of the important quality parameters in a dynamic system such as food (Khan *et al.*, 2002).

In the present study health mixes were stored at ambient conditions for a period of three months. Microbial growth was analysed initially and also at 30 days intervals up to three months by viable plate count method. In the present examination there was no microbial growth in initial, first and second month. At the end of third month very low bacterial count was observed. Bacterial colonies were found in the treatments, T_4 and T_{10} in 10^{-6} dilution. In the case of 10^{-7} dilution bacterial growth was recorded in T_4 only.

Sensory evaluation of health mix during storage

Sensory evaluation was done to study the influence of storage on the acceptability of the products. In sensory shelf life studies, generally food samples with different storage times are presented to consumers (Hough *et al.*, 2003).

The use of survival analysis to study the shelf life of foods is a novel technique in which the key concept is to focus on the shelf life estimation based on consumer rejection rather than on product deterioration (Gomez *et al.*, 2003).

In this study changes in the two selected health mixes were carried out periodically up to three months with respect to the sensory parameters using score cards by a panel of ten judges, to understand the deteriorative changes occurring in the stored products.

Results revealed that appearance, colour, flavor, texture and taste of health mix at the initial period scored high mean rank value (28.10). Mean rank values slightly decreased after 30 days' interval up to three months. There was no significant deference

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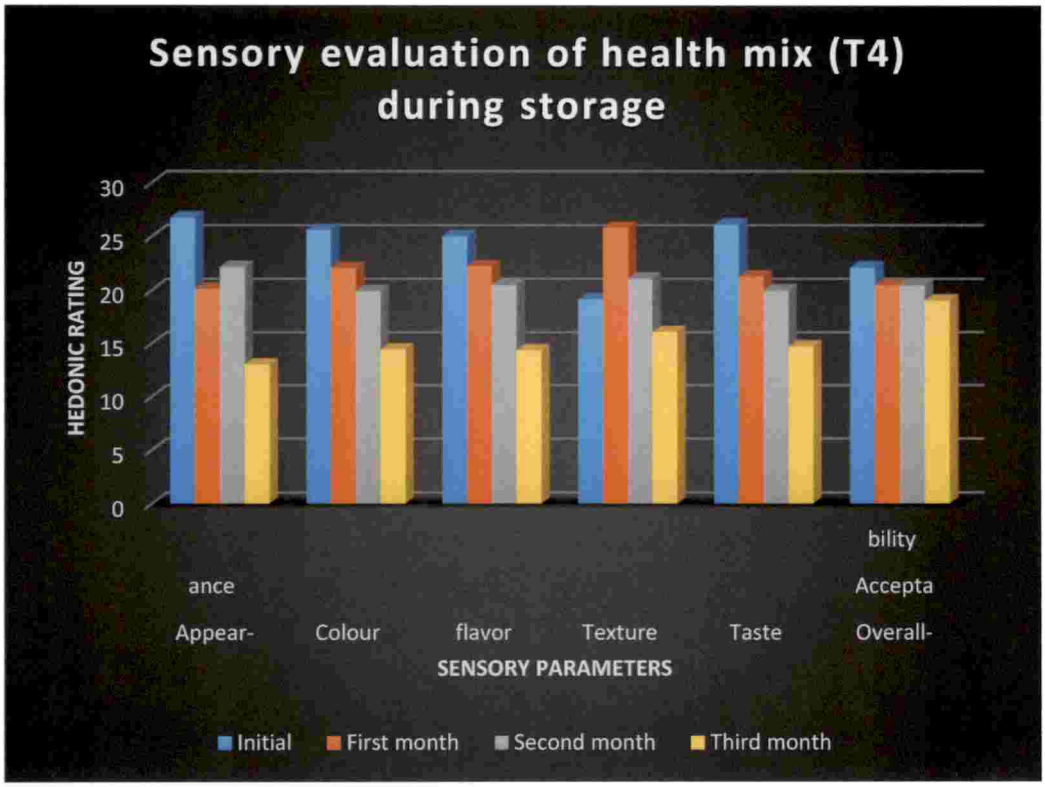

Fig 22. Sensory evaluation of health mix (T_4) during storage

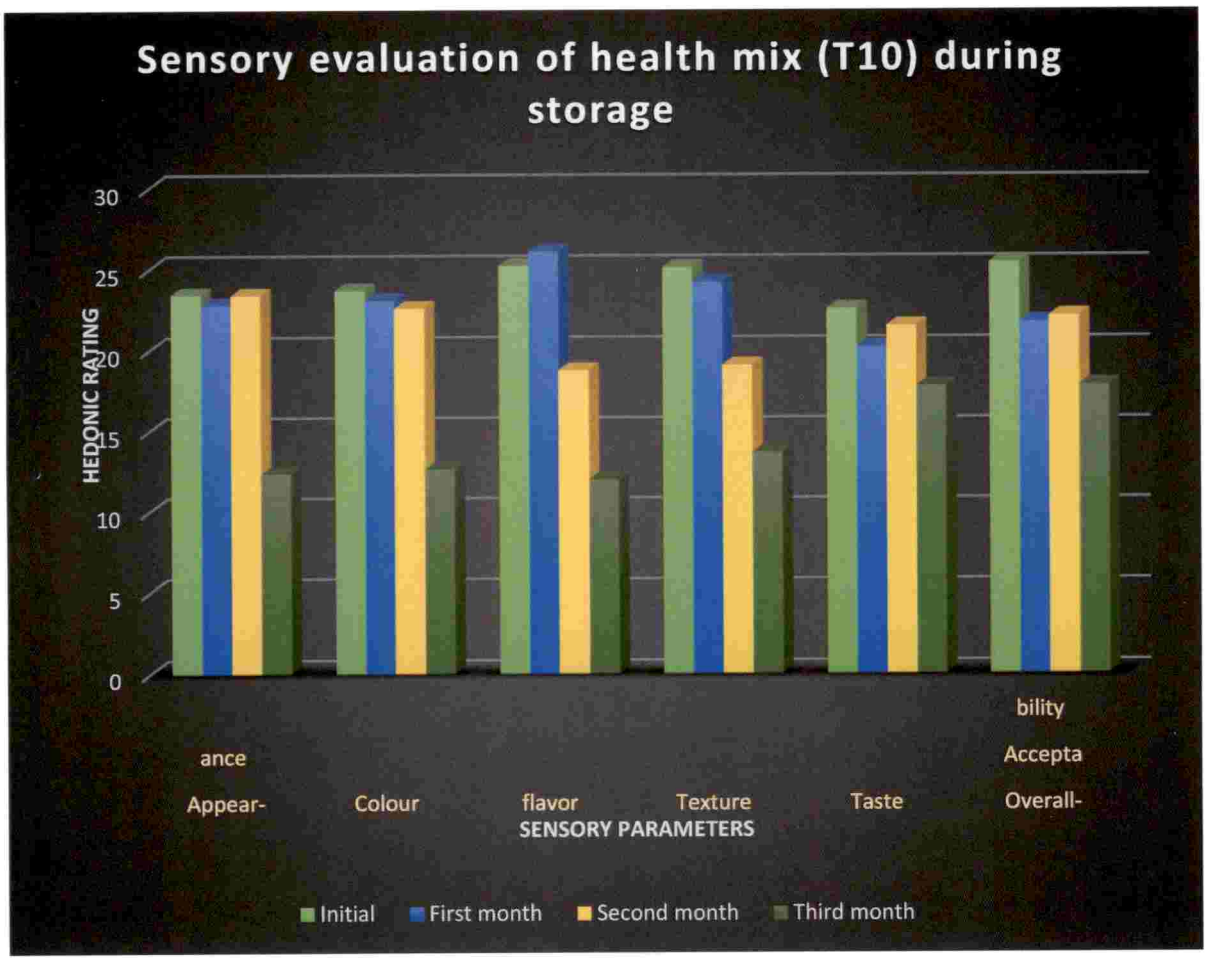

Fig 23. Sensory evaluation of health mix (T_{10}) during storage

between the scores. It means the acceptability scores of the health mix (T_4) were acceptable up to three months. Fig 22 depicts sensory evaluation of health mix (T_4) during storage

As for health mix T_{10} higher mean scores observed for the overall acceptability of the product at the initial period of storage was 26.40. Lower scores were observed at the period of three months (17.81). Statistical analysis showed that there was no significant difference between the scores. It means that acceptability scores of the health mix (T_{10}) were acceptable up to three months. Fig 23 depicts sensory evaluation of health mix (T_{10}) during storage.

Cost analysis

Cost of the developed health mixes were calculated by adding the cost of the ingredients used for the formulation of health mix, packaging materials and the overhead charges needed for processing each time. The cost of 1 kg packets of products were calculated. The cost of 1 kg health mix was calculated as Rs. 324 for T_4 (health mix with dehydrated vegetables) and Rs. 344 for T_{10} (health mix with dehydrated fruit bits).

Cost of the health mix T_4 can be reduced by adding locally available raw materials like plantain stem, plantain blossom, raw papaya and coloccasia stem etc instead of carrots, beans and onions. And in the case of T_{10}, locally available ingredients like ripe papaya, jack fruit and rose apple can be added instead of dates, pineapple and amla in honey.

In the present investigation the results revealed that the health mixes with nutritious, good shelf life and sensory quality could be standardized with nutritional ingredients like ragi, barley, oats and soya. Along with this nutritious health mixes based on locally available raw materials were formulated without artificial additives. They were found to be highly acceptable and low in cost comparison to market brands. at the time of present study.

SUMMARY

SUMMARY

The present investigation entitled 'Development and quality evaluation of Geriatric health mix,' was carried out with the aim of developing a consumer acceptable Geriatric health mix to senior citizens with the aim of supplementing energy and other nutrients in the diet. The objective of the study was to develop Geriatric health mixes and to evaluate their nutritional, functional, organoleptic and shelf stability. The experiment was carried out in the Department of Community Science, College of Agriculture, Vellayani, Thiruvananthapuram, during the period of 2016 – 2017. The major findings of the study are summarized below.

Base materials and other ingredients needed for the study were collected from the local shops. Millet and cereals such as Ragi, Wheat rava, Barley and Oats were selected as base materials for the development of the Geriatric health mix. Each of the raw materials were roasted, powdered and sieved. Soya, dehydrated vegetables, dehydrated fruit bits and skimmed milk powder were the other selected ingredients in the formulation of the health mixes. Vegetables such as onion, beans and carrots were dried, powdered and sieved. Dehydrated fruit bits such as dried pineapple and dates were crushed. Amla in honey was dried separately and mixed with the treatments after thorough mashing.

Two groups of formulations were tried out for the finalization of Geriatric health mix. Each group included five treatments. In the first group, dehydrated vegetables and in the second group dehydrated fruit bits were added along with the base materials and the other ingredients, in various amounts and proportions.

Proportions of base materials proposed in the health mixes were 60 gram and other ingredients were 40 grams. Base materials and other ingredients were dried separately and blended to obtain various formulations. From the proposed two groups of combinations, best three treatments of each group were selected; based on computed

energy and NDP Cal%. Energy and NDP cal% of each combination was computed to identify the best combination.

On the basis of computed energy and NDP Cal%, T_1, T_4 and T_5 comprising of the optimum proportion of ingredients were selected from the first group and T_6, T_9 and T_{10} were selected as best combinations from the second group.

Selected combinations of health mixes were processed into porridge and served hot to the sensory panel members. Each combination was scored based on sensory parameters for selecting the best combination. The best formulation identified from the first group was T_4 based on overall acceptability (24.60). This comprised of ragi, oats, soya, dehydrated vegetables and skimmed milk powder (their proportions being, 40g: 20g: 20g: 15g: 5g). From the second group T_{10} (25.10) which comprised of ragi, barley, soya, dehydrated fruit bits and skimmed milk powder was selected as the best combination (their proportions being, 40g: 20g: 20g: 15g: 5g).

For assessing the acceptability of the health mixes, 5 dishes were selected for both treatments. The products were 'steamed cake', 'dosa',' oratty', 'porridge' and 'elayappam'. The highest mean rank values were scored by the dish 'Elayappam' prepared from both the treatments followed by oratty, dosa, porridge and steamed cake. Consumer acceptability of the developed health mix based dishes were assessed among 30 elderly people selected at random.

The portion size of the health mixes were determined. One portion of health mix was computed as 200 g, as this would meet one third requirement of the RDA of energy. This amount could be had as one meal or two meals.

Functional properties, nutrient analysis and chemical composition of the health mixes were analyzed. In functional qualities, yield ratio, bulk density and cooking characteristics of the product were studied. The yield ratio of developed health mixes were found to be 0.83 for T_{10} and 0.45 for T_4. In the case of bulk density, T_{10} had higher

bulk density (0.66) and the lesser value was observed for T_4 (0.55). Time taken for cooking 20 g of health mix with 250 ml of water was 10 minutes and its yield was found to be 40 g.

Chemical composition of the developed health mixes were studied with respect to moisture, acidity, total ash and peroxide value. Chemical composition of the products revealed that moisture, acidity, total ash and peroxide value for T_4 were 2.60%, 0.20%, 2.82g and 1.44 meq /Kg respectively. As for T_{10}, it was 3.04%, 0.29%, 2.88g and 0.91 meq/ Kg respectively.

Nutrient composition of the developed health mixes were analyzed using the standard procedures with respect to the energy, protein, carbohydrate, iron, calcium, potassium, sodium and fibre. Nutrient composition of the developed mixes revealed that energy, protein, carbohydrate, iron, calcium, potassium, sodium and fibre for T_4 was level to be 310.03Kcal, 18.80g, 54.07g, 5.08mg, 272.52 mg, 172.54 mg, 5.88 mg and 7.50 % respectively. In the case of T_{10}, it was 309.72 Kcal, 17.98 g, 54.21g, 4.43 mg, 270.45 mg, 174.34 mg, 6.37 mg and 7.87% respectively.

The developed health mixes were packed and kept for three months to assess their shelf life at ambient conditions. The moisture, acidity and peroxide content values were seen to increase with storage, but were within the prescribed limits. Microbial growth was not found during the initial, first and second month. But, bacterial growth was found in negligible amounts after the third month. However, Sensory evaluation of the products during storage period revealed, acceptable results. Hence this study confirms that low cost and nutritious health mixes with good sensory quality and shelf life could be standardized with nutritional ingredients like ragi, barley, oats and soya.

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APPENDICES

APPENDIX- I

SCORE CARD FOR SELECTING BEST COMBINATION FOR GROUP 1

PARTICULARS	TREATMENTS		
	T_1	T_4	T_5
Appearance			
Colour			
Flavour			
Texture			
Taste			
Overall Acceptability			

*Kindly indicate your rating between 1-9 (1 stands for poor and 9 stands for excellent)

NAME:

SIGNATURE:

APPENDIX- II

SCORE CARD FOR SELECTING BEST COMBINATION FOR GROUP 2

PARTICULARS	TREATMENTS		
	T_6	T_9	T_{10}
Appearance			
Colour			
Flavour			
Texture			
Taste			
Overall Acceptability			

*Kindly indicate your rating between 1-9 (1 stands for poor and 9 stands for excellent)

NAME:

SIGNATURE:

APPENDIX- III

HEDONIC RATING FOR CONSUMER ACCEPTABILITY OF THE PRODUCT

Particulates	**Score**	**T_4**	**T_{10}**
Like extremely	9		
Like very much	8		
Like moderately	7		
Like slightly	6		
Neither like nor dislike	5		
Dislike slightly	4		
Dislike moderately	3		
Dislike very much	2		
Dislike extremely	1		

(Taste these samples and check how much you like or dislike each one. Use the appropriate scale to show your attitude by checking at the point that best describes your feelings about the sample.)

Signature:

Name :

ABSTRACT

DEVELOPMENT AND QUALITY EVALUATION OF GERIATRIC HEALTH MIX

by

THASLEEMA SALAM

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Abstract of the thesis

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ABSTRACT

The present study entitled "Development and quality evaluation of Geriatric health mix", was conducted in the Department of Community science, College of Agriculture, Vellayani during the period of 2016 – 2017. The objective of the study was to develop Geriatric health mixes and to evaluate their nutritional, functional, organoleptic and shelf stability. The study was intended to develop a consumer acceptable Geriatric health mix to the targeted individuals, that could supplement energy and other nutrients in the diet.

Millet and cereals such as ragi, wheat rava, barley and oats were selected as base materials for the development of the health mix. The base materials were collected from the local shops. They were roasted, powdered and sieved. Ingredients such as soya flour, dehydrated vegetables, dehydrated fruit bits, skimmed milk powder and food adjunct were the other constituents in the formulation of health mix. The food adjunct added was cardamom. For standardization of the health mixes two groups of formulations were tried out for the finalization of geriatric health mix. First group included dehydrated vegetables carrots, beans and onions. Second group comprised of dehydrated fruit bits which included dried pineapple, dates and amla in honey.

First group included treatments one to five and the second group included treatments six to ten. Best three treatments of each group were selected based on computed energy and NDP CAL%. Thus from first group, T_1 (which comprised of wheat rava, oats, pulse, dehydrated vegetables and skimmed milk powder), T_4 (which comprised of ragi, oats, soya, dehydrated vegetables and skimmed milk powder) and T_5 (which comprised of ragi, barley, soya, dehydrated vegetables and skimmed milk powder) were selected as the best combinations and in second group T_6 (which comprised of wheat rava, oats, soya, pulse, dehydrated fruit bits and skimmed milk

powder), T_9 (which comprised of ragi, oats, soya, dehydrated fruit bits and skimmed milk powder) and T_{10} (which comprised of ragi, barley, soya, dehydrated fruit bits and skimmed milk powder) were selected as the best combinations.

Each treatment from the two groups were then processed into porridge and served hot to the sensory panel members. Each combination was scored based on sensory parameters for selecting the best combination. The best formulation identified from first group was T_4 which comprised of ragi, oats, soya, dehydrated vegetables and skimmed milk powder (their proportions being, 40g: 20g: 20g: 15g: 5g). From the second group T_{10} which comprised of ragi, barley, soya, dehydrated fruit bits, skimmed milk powder was selected as the best combination (their proportions being, 40g: 20g: 20g: 15g: 5g).

Assessment of consumer preference was conducted among 30 elderly people selected at random. Functional qualities of health mixes were analyzed. Yield ratio for T_4 was 0.45 and for T_{10} it was 0.83. In the case of bulk density, T_{10} recorded a value of 0.66 and T_4 recorded a value of 0.55. Chemical analysis of the product revealed that moisture, acidity, total ash and peroxide value for T_4 were 2.60%, 0.20%, 2.82g and 1.44 meq /kg respectively. And for T_{10} it was 3.04%, 0.29%, 2.88g and 0.91 meq/ kg respectively.

Nutrient profile of the developed health mix (T_4) revealed energy, protein, carbohydrate, iron, calcium, potassium, sodium and fiber level to be 310.03kcal, 18.80g, 54.07g, 5.08mg, 272.52 mg, 172.54 mg, 5.88 mg and 7.50 % respectively. In the case of T_{10}, it was 309.72 kcal, 17.98 g, 54.21g, 4.43 mg, 270.45 mg, 174.34 mg, 6.37 mg and 7.87% respectively.

The developed health mixes were packed and kept for three months to assess shelf life at ambient conditions. The moisture, acidity and peroxide content were seen to increase with storage, but were within the prescribed limits. Microbial growth was absent during the initial, first and second month. However low bacterial count could be observed after the third month. But sensory evaluation of the products during storage

period revealed acceptable results. Hence this study confirmed that health mixes with good sensory quality and shelf life could be standardized with nutritional ingredients like ragi, barley, oats and soya.

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