DEVELOPMENT OF NUTRITIONALLY DENSE PREMIXES FOR IMPROVING THE DIETARY DIVERSITY AMONG PRE-SCHOOLERS.

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B.Sc (Hons.)

(Food, Nutrition and Dietetics)

DEVELOPMENT OF NUTRITIONALLY DENSE PREMIXES FOR IMPROVING THE DIETARY DIVERSITY AMONG PRE-SCHOOLERS.

A Dissertation Submitted In Partial Fulfilment Of The Requirement For The Degree Of Masters Of Science

(Family and Community Sciences)

(Public Health Nutrition)

By

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CERTIFICATE

THIS IS TO CERTIFY THAT THE RESEARCH WORK EMBODIED IN THE RESULT OF THIS DISSERTATION HAS BEEN CARRIED OUT INDEPENDENTLY BY MISS SHEETAL PASI IN PURSUIT OF A MASTER DEGREE IN PUBLIC HEALTH NUTRITION AND REPRESENTS HER ORIGINAL WORK.

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ABSTRACT

Abstract

Malnutrition in children below 5 years of age is a concern as the prevalence around the globe is still in the higher range even though there has been a decline over the last decade. Children belonging to the pre-school age group (3-5 years) are more vulnerable to developing undernutrition as they are in period of rapid growth and development. Meeting nutritional requirements of pre-schoolers is a tough task as they are often picky eaters which fluctuating appetite levels, also as both parents are entering the workspace the dependence on convenience foods has increased. One of the convenience foods that have become famous among parents of pre-schoolers are premixes. Premixes are products which include variety of ingredients mixed together during manufacturing and packaged and which can be reconstituted or incorporated in recipes.

Thus, the present study was conducted while keeping the following objectives in mind: to develop nutritionally dense premixes for improving dietary diversity among pre-schoolers, to develop recipes in which the developed premixes can be incorporated and to conduct sensory evaluation of the premix incorporated recipes

Five multigrain premixes were developed which constituted of cereal (wheat -8g) and legume (soybean-8g) as the common ingredients while millets/pseudo millet (bajra/ jowar/ragi/kodari/amaranth – 15g each) were the variable ingredients. The average energy content of the premixes was 106.6 ± 1.95 kcal. The average carbohydrate, protein and fat content were 15.66 ± 0.44g, 5.38 ± 0.34 g and 2.18 ± 0.28 respectively.

The five developed multigrain premixes were incorporated in eight recipes viz. Cheela, Gud roti, Handva, Idli, Kothimbir vadi, Seviyaan kheer, Thalipeeth and Tikki. During the preparation of the recipes, other ingredients like fruits, vegetables, milk and milk products were also incorporated which in turn helped in increasing the dietary diversity of the recipes. The recipes were developed to fulfil one fourth of the Estimated Average Requirement (EAR) of pre-school children.

Sensory evaluation of the eight recipes made from the premix variants was carried out by 30 semi-trained panellists. Average composite rating scale scores for all the sensory attributes (colour and appearance, aroma, texture, taste, aftertaste, mouthfeel and overall acceptability) of the recipes were above 7 out of 10 and the average total scores were above 50 out of 70. When the composite rating test scores of individual recipes made from different developed

multigrain premixes were compared, it showed that all the recipes made from the developed multigrain premixes were found to be highly acceptable for all the attributes by the panellists. Gud roti was the only recipe where significant differences were found in all the attributes. Gud roti made from amaranth premix had the highest average total score in the composite rating scale test. The composite rating test scores of different recipes made from the same developed multigrain premix showed that for all the recipes, the recipes made from ragi premix had the lowest scores comparatively. Hedonic score for all the multigrain premix incorporated recipes were above 5 which indicates that they were accepted and liked by the sensory evaluation panellists. Hedonic scores of different recipes made from the same developed multigrain premix had similar scores, which were above 5 indicating that the premixes were well accepted in form of all the recipes. A booklet was developed which comprised information about the developed multigrain premixes and the recipes made using them with the purpose of disseminating it among general population.

Thus, it can be concluded that the five developed multigrain premixes and the recipes made from them were highly accepted and could be used to include in diet of pre-school children to improve their dietary diversity and their nutritional status. These premixes can be distributed as take home ration to children belonging to pre-school age through various government schemes in order to correct and prevent malnutrition and improve overall nutritional status.

INTRODUCTION

Introduction

Malnutrition is defined as "deficiencies, excesses or imbalances in a person's intake of energy and/or nutrients." Globally, it is considered one of the most important risk factor for illness and death especially among pregnant and lactating women and children under five years of age.

Malnutrition is categorised into tow broad group of conditions:

- Undernutrition including of stunting (low height for age), wasting (low weight for height), underweight (low weight for age) and micronutrient deficiencies.
- Overweight, obesity and diet related non-communicable diseases.

According to UNICEF (2015), approximately 50% deaths of children under five years of age are due to complications caused by undernutrition. Undernutrition increases the risk of death from common infections and their frequency, severity and recovery rate.

Global prevalence of Undernutrition:

In 2019, 144 million children were stunted while 47 million suffered from wasting globally.

21.3% children under five years of age had stunted growth, the prevalence was high is particularly three regions – South Asia, East & Southern Africa and West & Central Africa. The stunting prevalence has dropped from 32.4% to 21.3% between the years 2000 and 2019. However, in West and Central Africa have increased from 22.4 million to 29.0 million which is of grave concern.

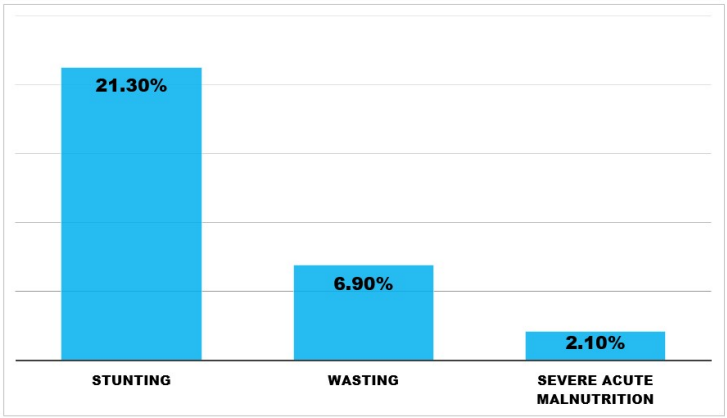
Prevalence of wasting is children was 6.9% whereas 2.1% children were severely wasted. 50% of all wasted children are inhabitants of South Asian region, whereas 25% of them live in sub-Saharan Africa with the trend remaining similar for severely wasted children. Wasting prevalence of 14.8% in South Asia reflects on the urgent need of appropriate intervention and treatment programmes.

Global prevalence of underweight among children has decreased from 20.8% to 13% between years 2000 and 2019.

TABLE 1.1: FORMS OF UNDERNUTRITION AND THEIR INDICATORS

Forms of undernutrition	Their indicators
Stunting	Height for age < –2 SD of the WHO Child Growth Standards median
Wasting	Weight for height < –2 SD of the WHO Child Growth Standards median
Underweight	Weight for age < –2 SD of the WHO Child Growth Standards median
Micronutrient Deficiencies	Iron deficiency: Hb level, Serum Ferritin, RBC distribution width, Transferrin receptor1 and Total iron binding capacity (TIBC) Vitamin A deficiency: Serum retinol, dark adaptometry and Rose-Bengal eye test Zinc deficiency: Indirect method of estimating zinc status of diets in various geographic areas Iodine deficiency: Median Urinary Iodine, Filter paper TSH test for neonates, Thyroglobulin test, Ultrasound measurements of thyroid Vitamin D deficiency: Serum Vitamin D level Vitamin B complex deficiency: Serum methyl malonic acid and homocysteine levels

FIGURE 1.1: GLOBAL PREVALENCE OF UNDERNUTRITION IN CHILDREN UNDER FIVE YEARS OF AGE.



Source: UNICEF/WHO/World Bank Joint Child Malnutrition Estimates, March 2020 edition.

National prevalence of Undernutrition:

According to the Global Hunger Index (2019), India ranked 102 out of a total of 119 countries. India has 46.6 million children suffering from stunting.

As per National Family Health Survey (NFHS 4, 2015-16), prevalence of stunting, wasting and underweight are 38.4%, 21% and 35.7% respectively. A more recent national level scenario of undernutrition was documented by the Comprehensive National Nutrition Survey (CNNS, 2016-18) report. According to CNNS, prevalence of stunting, wasting and underweight in children aged 0-4 years are 35%, 17% and 33%. Prevalence of childhood severe acute malnutrition (severe wasting) is 11%.

Regional prevalence of Undernutrition:

The UNICEF Rapid Survey which covered India in 2016, showed that 10.1% children were underweight and 41.6% of them were stunted in Gujarat. National Family Health Survey - 5 (2017-18) showcased prevalence of stunting, wasting and underweight among children as 38.5%, 26.4% and 39.3% in Gujarat.

Management of Undernutrition:

Management of severe undernutrition involves the following points:

1. Providing adequate nutrition through a balanced daily diet which involves food from all the food groups so as to match the daily requirements of macro and micro nutrients. Thus, exclusive breastfeeding for 6 months 6 age and complementary feeding including diverse food is of utmost importance.

2. Repetitive diseases, mainly infection causing diarrhoea should be prevented as it leads to repeated cycles of severe dehydration and direct nutrient loss and malabsorption which reduces the appetite of the child which further reduces immunity to infections thus trapping it in a viscous cycle.

3. Therapeutic foods as intervention for prevention and treatment of undernutrition. Most commonly used formulated therapeutic foods are F75 and F100.

Management of moderate undernutrition involves the following points:

1. Strategies for prevention: It includes promotion of exclusive and appropriate breastfeeding and complementary feeding practices, improved sanitation and hygiene habits, and prevention and timely treatment of diseases. Interventions like multiple micronutrient powders, less quantity of Lipid based Nutrient Supplement (LNS) along with single nutrient supplements are used to increase nutrient content of home diets.

2. Strategies for treatment: WHO recommends supplementary foods for managing MAM in children 6-59 months in the form of locally available, nutrient-dense foods for improvement in nutritional status and prevent SAM. 25 kcal/kg/day of energy intake is suggested along with addition to the standard nutrient requirements to support a steady rate of weight gain without leading obesity. In cases of food shortage, supplementary foods are supplied with optimal effectiveness. In populations with high food security, the primary caretakers of the undernourished children can be counselled and encouraged to use high-quality foods in preparation of meals at home for the children along with promoting sanitation and hygiene practices. In food insecure populations and humanitarian emergency contexts, Supplementary Food Packets (SFPs) are distributed with an objective of reduction in mortality and prevention of further deterioration of children's health.

Thus, the first five years of a child's life is crucial, though children till the age of 2 are given the most care as compared to children above 3 years of age because of various reasons like arrival of younger sibling, fuzzy eating, spending time away from home (preschool, day-care), etc. Thus, it is important to focus on prevention of development of undernutrition in children belonging to the pre-schooler age group (3-6 years) to avoid manifestation of health disorders and undernutrition in younger children and adolescents.

FIGURE 1.2: NATIONAL PREVALENCE OF UNDERNUTRITION IN CHILDREN UNDER FIVE YEARS OF AGE

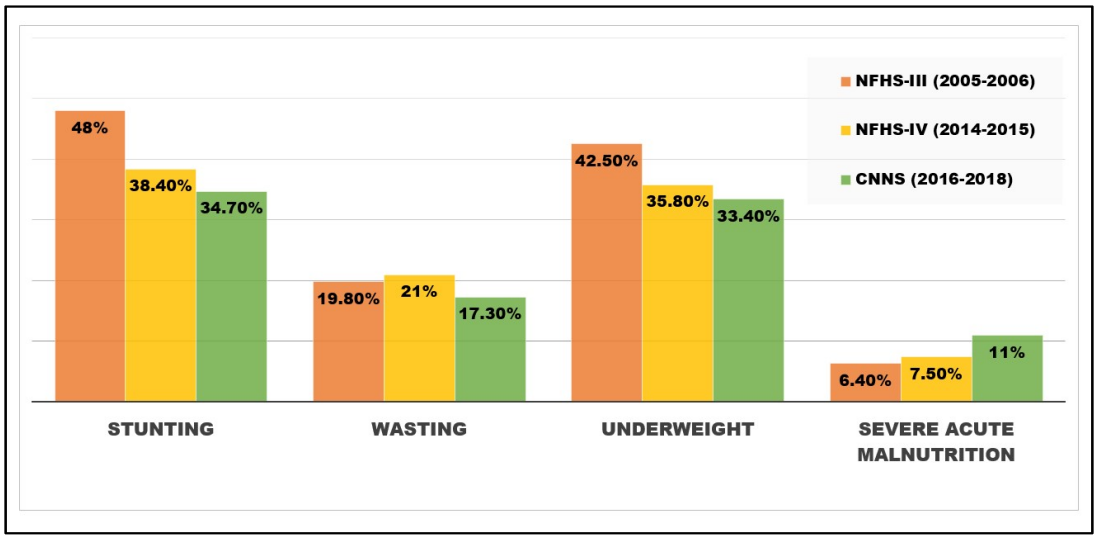
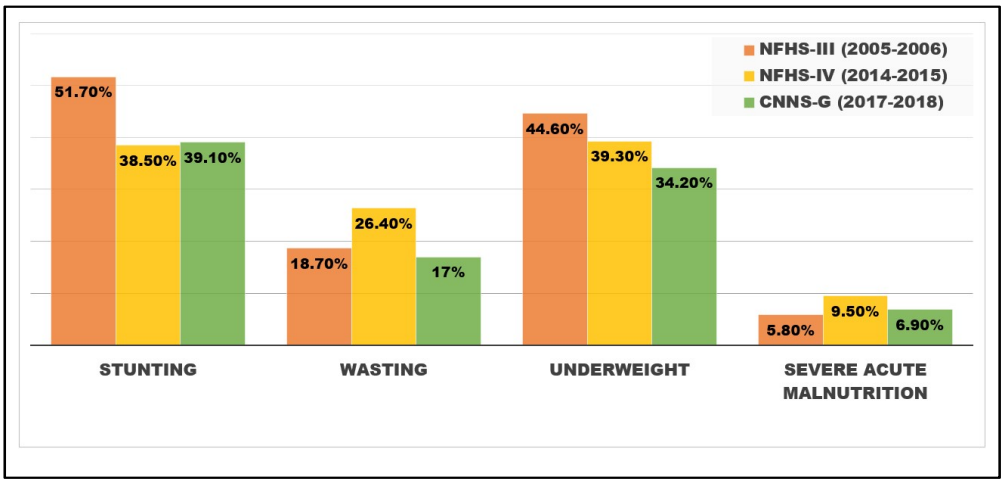


FIGURE 1.3: REGIONAL PREVALENCE OF UNDERNUTRITION IN CHILDREN UNDER FIVE YEARS OF AGE



Preschoolers:

Preschoolers are children belonging to the age group of 3 to 5 years according to the Centers for Disease Control and Prevention (CDC). In this age group, there is rapid development and growth, mentally and physically which increases energy and nutrient requirements too. Preschoolers go through changes socially too, as they start spending time away from home in preschools or day care centers where they mingle with their fellow mates and socialize which comes with increased risk of infections e.g. Flu which can challenge their immunity. Most children belonging to this age group are fuzzy eaters and dislike eating vegetables, fruits and wholegrain cereal and pulse. Thus, meeting nutritional requirements of preschoolers is a challenging task. This puts them at high risk of developing undernutrition.

To ensure adequate energy and nutrient intake one of the most important point is to add dietary diversity to daily diets. Dietary diversity is defined as the number of different foods/food groups consumed over a reference period. Choosing to include foods from all food groups in the daily diet of preschoolers in a balanced amount makes sure that the energy and nutrient requirements are met adequately.

National Nutrition Programs like ICDS and MDM with an aim to combat malnutrition in the country, provide supplementary nutrition meals in form of either Take Home Ration or Hot cooked meals to beneficiary groups (Pregnant and Lactating mothers, Children 6months to 36months of age, Children 3 years to 6 years of age). Some states have developed nutrient dense Take Home ration premixes. For example: Balbhog in Gujarat, Bal Ahar in Madhya Pradesh, Amrutham Nutrimix in Kerala, etc. However, these THR are provide mostly to children in the age range of 6-36 months and to pregnant and lactation women. The preschoolers are provided only hot cooked meals in the Aanganwadi. The menu in various states normally include khichdi, daliya, kheer, laddo, etc. These food items lack dietary diversity and thus fail to provide optimal nutrition to the children.

Health of preschoolers are also compromised when both their parents especially mothers are working; as it leaves the children under the care of their older siblings, grandparents or left to look after themselves. This results into increased reliance on convenience foods that are easy to cook/prepare and consume less time. However, the convenient foods available commercially are most often nutritionally unhealthy as the contain high amounts of refined cereal, sugar, fat, sodium, additives and preservatives. Hence, there is a need to fill the gap with easy to prepare/

ready to eat foods that are convenient, nutrient dense, affordable and made with ingredients that aim at improving the dietary diversity of the children.

One of the most commonly used convenient foods are premixes. Premixes are defined as “A substance or product consisting of ready-mixed materials.” or “A mixture of ingredients designed to be mixed with other ingredients before use.” They can be easily reconstituted and cooked as per need and convenience. Premixes when manufactured using food items belonging to various food groups so that they are a wholesome meal in themselves can help in increasing nutrient intake and improving dietary diversity among preschoolers.

Rationale of the study:

There is a lack of nutrient dense premixes that would improve dietary diversity of preschoolers which would help in prevention of different forms of undernutrition.

Hence, the current study is planned to develop the premixes and recipes from the premixes which would be subjected to sensory evaluation so as to aid in improvising the dietary diversity of home cooked meals given to preschoolers

REVIEW OF LITERATURE

Review of Literature

For human development, adequate nutrition is an important factor as it not only affects an individual's life but also societal development. Early stages of an individual's life are a crucial stage as the foundation of health and wellbeing is laid in this period. Lack of proper nutrition during childhood can lead to chronic or acute malnutrition which has a prominent effect even on the coming adult years of an individual. Thus, understanding the cause of malnutrition and its prevention and management in the early years of one's life ensures a healthy life ahead.

Malnutrition

Malnutrition is defined as "deficiencies, excesses or imbalances in a person's intake of energy and/or nutrients." It is categorised into tow broad group of conditions:

1. Undernutrition including of stunting, wasting, underweight and micronutrient deficiencies.
2. Overweight, obesity and diet related non-communicable diseases.

Undernutrition represents itself in various forms, especially in children below five years of age:

i. Stunting: It is defined as "low height for age". It develops over a long period of time when growing with limited access to food and other healthcare facilities. Stunting is also referred to as chronic malnutrition.

ii. Wasting: Wasting is defined as "low weight for height", also known as acute malnutrition as it develops over a short span of time with rapid worsening of nutritional status. Acute malnutrition is further categorized into Moderate Acute Malnutrition (MAM) and Severe Acute Malnutrition (SAM).

iii. Underweight: It is defined as "low weight for age", it is a composite indicator seen in chronic as well as acute nutrition.

iv. Micronutrient Deficiencies: Nutrients required by the human body in trace amounts (<100mg/day) are called as micronutrients and their deficiencies are also known as "Hidden Hunger". Some of the most prevalent micronutrient deficiencies in children are – Iron deficiency, Vitamin A deficiency, Zinc deficiency, Iodine Deficiency, Vitamin D deficiency and Vitamin B-complex deficiency.

Prevalence of Malnutrition Globally:

1 in 9 individuals under 5 years of age are hungry or undernourished, with figures growing since 2015, particularly in Africa, West Asia and Latin America, with 820 million globally. According to World Health Organization's 2019 factsheet, on a global level the number of children under five years of age that are stunted, wasted and severely malnourished are 155 million, 52 million and 17 million.

45% of deaths in children under five years of age is associated to undernutrition. These statistics are mostly seen in low and middle income countries where childhood overweight and obesity are on the rise too, thus showcasing double burden of malnutrition. According to the recent data published in the UNICEF-WHO-WB Joint Child Malnutrition - 2021 edition, there were 149.2 million stunted children, 45.4 million wasted children, and 38.9 million overweight children in the world. (figure 2.1). Prevalence of wasting and stunting is higher in the south Asian and middle & eastern African regions. (figure 2.2 and figure 2.3)

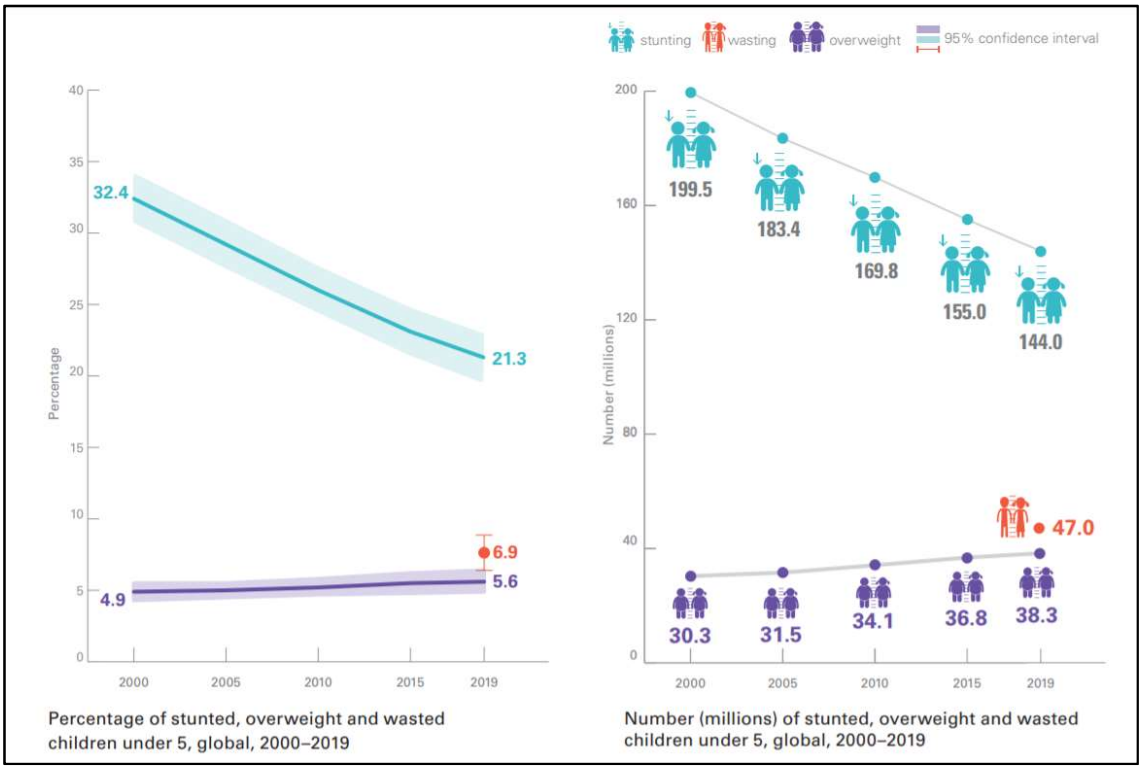
Table 2.1 depicts the percentage of children suffering from malnutrition countries classified based on their income.

A study done by Mawa and Lawoko in Uganda states that in order reduce prevalence of stunting and wasting in children belonging to under 5 years of age interventions must be made to improve maternal nutritional status and formal education among the mothers of the children.

According to a study conducted by Black et all (2013) which focused on maternal and child undernutrition in low and middle income countries, out of the total death of children under 5 years of age globally in 2015, 13% mortality was attributed to wasting which were preventable.

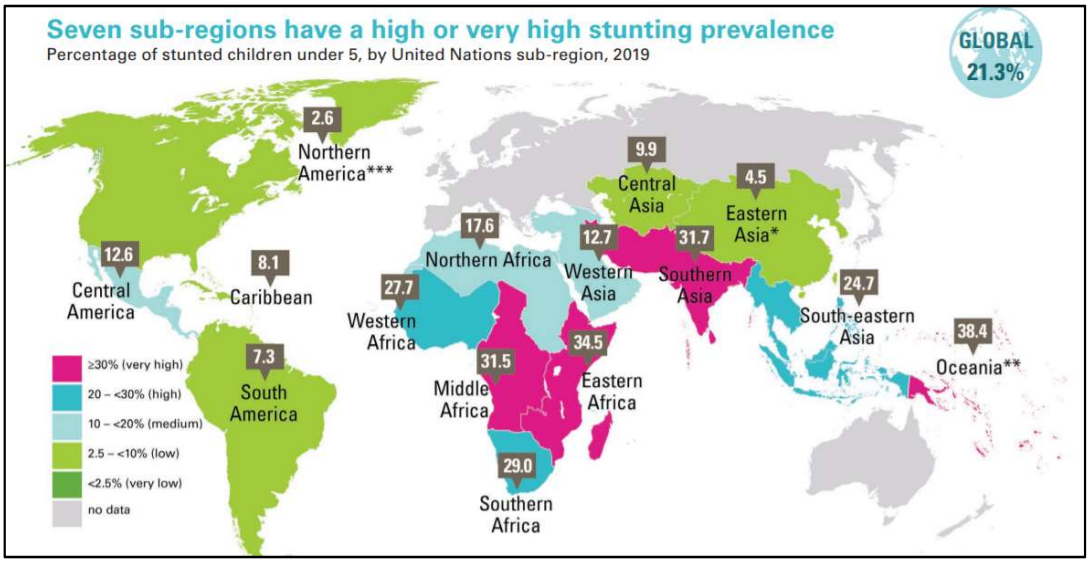
A study done on under five wasting in the South Asian region (Harding et al, 2018), concluded that wasting was much more prevalent in infants (0-5 months) while older children (24 to 35 months) were more vulnerable to stunting in the south Asian region.

FIGURE 2.1: PREVALENCE OF MALNUTRITION IN CHILDREN UNDER 5 YEARS ON A GLOBAL LEVEL FROM 2000 – 2019.



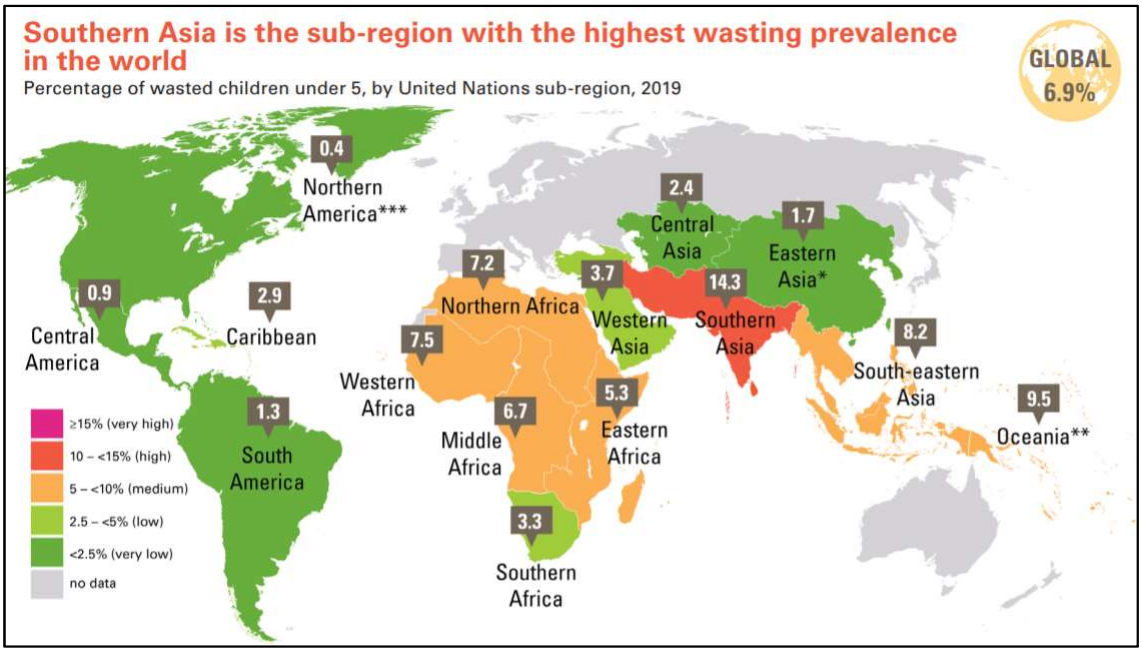
Source: UNICEF, WHO, World Bank Group joint malnutrition 2020 edition.

FIGURE 2.2: PREVALENCE OF STUNTING IN CHILDREN BELOW 5 YEARS OF AGE IN THE DIFFERENT SUB-REGIONS



Source: UNICEF, WHO, World Bank Group joint malnutrition 2020 edition.

FIGURE 2.3: PREVALENCE OF STUNTING IN CHILDREN BELOW 5 YEARS OF AGE IN THE DIFFERENT SUB-REGIONS



Source: UNICEF, WHO, World Bank Group joint malnutrition 2020 edition.

TABLE 2.1: PERCENTAGE OF MALNOURISHED CHILDREN LIVING IN DIFFERENT COUNTRIES OF THE WORLD CLASSIFIED BASED ON THEIR INCOME.

Countries classified based on their incomes	Number of children suffering from stunting.	Number of children suffering from wasting.
Low income countries	27%	17%
Lower-middle income countries	64%	75%
Upper-middle income countries	8%	7%
High income countries	1%	1%

Source: UNICEF, WHO, World Bank Group joint malnutrition 2020 edition.

Prevalence of stunting in the sub –African region peaked at 2 years of age and was higher in males as compared to females, according to a study on urban South African children conducted by Nyati et all (2019).

Prevalence of Malnutrition in India:

According to the NFHS – 4, prevalence of stunting and wasting in the country is 34.7% and 17.3% respectively. Figure 2.3 and 2.4 illustrates prevalence of stunting and wasting in children under 5 years of age in India from 2006 – 2017. According to the figure 2.3, prevalence of stunting has reduced in all the age groups except for 24-35 months. As per figure 2.4, prevalence of wasting increased for all the age groups in the year 2015 and is now gradually decreasing.

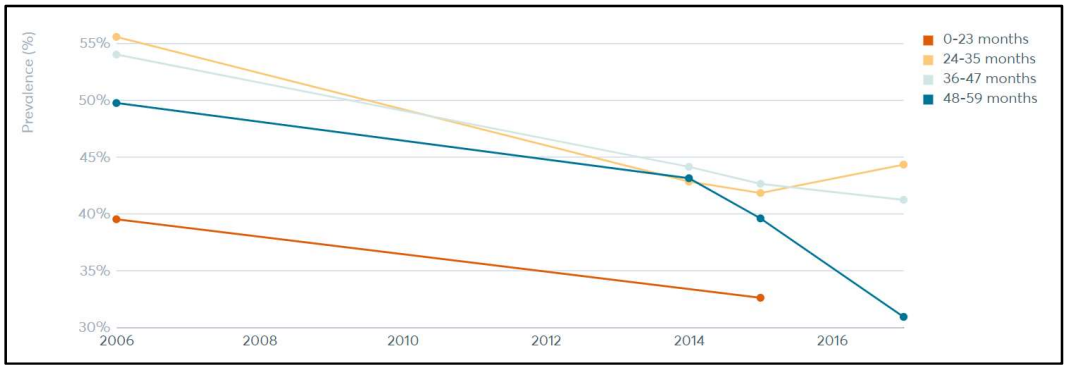
According to the first round of data published under NFHS-5, the prevalence of stunting has increased in 13 out of 22 states. Gujarat had the highest prevalence (39%) followed by prevalence in Maharashtra, West Bengal and Telangana which is 35%, 33.8% and 33.1% respectively. The lowest prevalence was in Kerala (23%). Out of 22 states, 16 states reported increase in underweight and severely wasted under 5 children as compared to NFHS-4 data with Telangana, Bihar, Kerala, Assam, Jammu and Kashmir toping the chart in terms of under 5 wasting prevalence.

A study done by Akhade et al (2019), revealed that prevalence of underweight, stunting and wasting in children below 5 years was 39.8%, 36.5% and 24.8% respectively in urban slums of Mumbai. Another study done by Sethy et al in urban slums of Odhisa state showed prevalence of under-five underweight, wasting and stunting as 55.3%, 75% and 42% respectively.

In a study conducted in Lucknow by Aggarwal and Srivastava (2017), significant association was found between prevalence of under-five undernutrition and educational status of mother and late initiation of breastfeeding. Only 20% of the children surveyed in the study received adequate supplementary feeding.

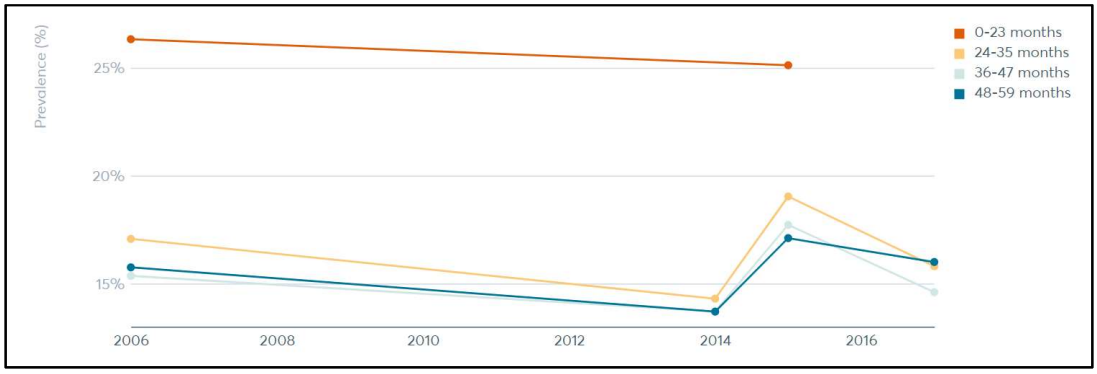
A study done by Swaminathan and Akshay (2019) based on NFHS 2015-16 data revealed that 6% of mother-child pairs suffer from Double Burden of Malnutrition (DBM). DBM was higher among mother-children pairs which belonged to rich wealth quintile as compared to mother-child pair belonging to poor wealth quintile.

FIGURE 2.4: PREVALENCE OF STUNTING IN CHILDREN UNDER 5 YEARS OF AGE IN INDIA



Source: UNICEF, WHO, World Bank Group joint malnutrition 2020 edition.

FIGURE 2.5: PREVALENCE OF WASTING IN CHILDREN UNDER 5 YEARS OF AGE IN INDIA



Source: UNICEF, WHO, World Bank Group joint malnutrition 2020 edition.

Prevalence of Malnutrition in Gujarat:

According to NFHS – 5 data, prevalence of under-five stunting, wasting and underweight in the state of Gujarat is 39%, 25.1% and 39.7% respectively. The prevalence of stunting and underweight has increased when compared to NFHS – 4 data, severe wasting increased by 1.1% too. Comprehensive Nutrition survey in Gujarat showed more prevalence of stunting, wasting and underweight in rural areas (42.7%, 19% and 38.7% respectively) as compared to urban areas (33.8%, 13.9% and 27.3 respectively) which was associated with less number of mothers being literate in rural areas (57.8%) as compared to their urban counterparts (77.2%).

A study done by Ritu Rana in 2020 stated that in Narmada district of Gujarat, prevalence of stunting and underweight in children below 2 years of age was 32.2% and 34.5% respectively.

In another study done by G.B. Sahu (2018), prevalence of under-five stunting and underweight in tribal children of Narmada district was found to be 58.4% and 44.4% respectively.

Rastogi et al (2017) conducted a study wherein they used WHO Anthro software for assessing malnutrition among children belonging to below 5 years of age – the results concluded that in urban area prevalence of stunting, wasting and underweight was 31.4%, 41.7% and 36.9% respectively whereas the prevalence in rural area was 54.3%, 35.3% and 56.3%. Educational status of mother along with working status, low socioeconomic and rural environment were highly associated with children's nutritional status.

In a study done by Sahoo et al (2019), it was seen that in the six administrative regions of Gujarat prevalence of underweight in children belonging to the age group 24-59 months was low in children who consumed a combination of cereals, vegetables, pulses and milk/milk products as compared to children consuming just cereal and milk.

In a study done by Gandhi and Shah (2020) stated that decline in prevalence of under-five stunting was observed between the year 2014 – 19 in the state of Gujarat, however no changes were seen in wasting and underweight prevalence.

A study done by Biplab Dhak (2021), concluded that the reason behind slow improvement in child nutritional status in Gujarat is increased socio-economic inequalities and inter district disparities.

Ishwarji et all (2019) studied regional prevalence of undernutrition among children below 5 years of age in different districts of Gujarat. 44%, 42% and 20% was the overall prevalence of

underweight, stunting and wasting respectively. The prevalence was significantly higher in the central region as compared to Saurashtra and Kutch region. Minimum dietary diversity was higher in Saurashtra region and lower in North region.

Pre-schoolers:

Preschoolers are children belonging to the age group of 3 to 6 years according to the Centre for Disease Control and Prevention (CDC). In this age groups there is growth and development both, physically and mentally. Their trunk region and limbs and more importantly the legs grow in size. The motor cortex region which controls voluntary movements of the brain develops rapidly. This enables them to learn and perform various physical activities like jumping, kicking, running, climbing, skipping, and throwing. They also develop fine motor skills like coloring, stringing beads together, cutting papers with scissors, drawing, etc. Some of the essential factors for optimal physical and mental development of children belonging to this age group is adequate dietary intake and sufficient availability of nutrients in their diets. Their nutritional requirements are dependent on their basal metabolic rate, energy expenditure due to physical activity and rate of growth. Pre-schoolers are prone to malnutrition especially undernutrition (stunting, wasting and underweight) due to factors such as inadequate quantity and quality of dietary intake, recurring infections, cereal based diets with low quality protein in marginal amount. Problems with child's feeding practices and unavailability or inaccessibility of food items from all the food groups are other potential factors leading to undernutrition.

A survey conducted in Wayanad district of Kerala in the year 2015 by Philip et al, showed prevalence of stunting, wasting and underweight in pre-school children as 38%, 20.5% and 39%.

A small scale study from National institute of Nutrition (1994) showed that the dietary intake of pre-school children in urban slums was no better than those of rural pre-schoolers. The study showed that 81% of rural children and 92% of slum dwellers in Hyderabad suffered from current long duration malnutrition.

Meeting the dietary requirements of pre-schoolers is a rather daunting task for the parents/caregivers as there are various physical and behavioural changes. As the growth spurt slows down after 1 year of age, there is decline in the appetite to the kids which may worry the

parents. Additionally, pre-schoolers are more likely to develop picky-eating behaviours like choosing and accepting only few food items, reluctant to try new foods, aversion towards certain food groups like vegetables and fruits, strong preferences as to the style of food preparation and presentation which decreases their dietary intake.

In a study done by Corsi et al (2016) it was reflected that in India, top risk factors associated with underweight among children are – short maternal stature, maternal underweight, lowest wealth quintile, no education and low dietary diversity.

Dietary Diversity:

Dietary diversity is defined as the number of different foods or food groups consumed over a given reference period. Dietary diversity score is measured by summing the number of foods or food groups consumed over a reference period which usually ranges from 1-3 days, but 7 days is also often used. FANTA in 2006 released Household Dietary Diversity Score, following 12 food groups are used to calculate it:

- Cereals
- Root and tubers
- Vegetables
- Fruits
- Meat, poultry and offal
- Eggs
- Fish and seafood
- Pulses, legumes, nuts
- Milk and milk products
- Oil and fats
- Sugar and honey
- Miscellaneous

Estimation of dietary diversity score has been now lately used as a proxy for indicator of nutrient adequacy among population. In a study done on non- breastfeeding Filipino children,

Kennedy et al concluded that moving from a monotonous diet to one containing a more diverse range of foods increases intake of energy as well as micronutrients in developing countries.

In a study of school-aged children in Kenya by Ruel M et al (2007), the mean DDS was 5.18 (based on 7 food groups) which was concluded as the reason behind the mean MPA (mean probability of adequate micronutrient intake) being 70%.

Another study conducted by Hooshmand and Udipi (2013) on the subject of Dietary diversity and Nutritional status of urban primary school children in India and Iran showed a positive co-relation between height for age with score for pulses, dairy products and non-vegetarian food items. The data suggest that dietary diversity for cereals, mixed dishes, beverages, sweets and fat consumption as well as fruits and vegetables is associated with increasing Body Mass Index.

A comprehensive nutrition survey in Maharashtra by Chandreshekar S. et al (2017) showed that children from moderately food insecure and severely food insecure households were more likely to have lower diet diversity scores. Children from severely food insecure households were more likely to be stunted, underweight, or wasted, and the survey concluded a strong association between prevalence of undernutrition and low dietary diversity.

Data from an urban slum ICDS project in Delhi highlighted that children belonging to the age range of 6-36 months consumed 56% and 40% of sugar and fat of their daily recommendation while consumption of foods from other food groups was less than 50%. The deficit in the case of green leafy vegetables was as high as 87% (Kapoor et al, 2002).

As concluded from the above mentioned studies, poor dietary diversity is one of the causes for undernutrition. Efforts are needed in this direction so as to improve the dietary diversity among the pre-schoolers.

Programs like ICDS and MDM provide supplementary nutrition meals in form of either Take Home Ration or Hot cooked meals to beneficiary groups (Pregnant and Lactating mothers, Children 6 months to 36 months of age, Children 3 years to 6 years of age). Some states have developed nutrient dense Take Home ration premixes. For example: Balbhog in Gujarat, Bal Ahar in Madhya Pradesh, Amrutham Nutrimix in Kerala, etc. However, these THR are provide mostly to children in the age range of 6-36 months and to pregnant and lactation women. The

pre-schoolers are provided only hot cooked meals in the Aanganwadi. The menu in various states normally include khichdi, daliya, kheer, laddoo, etc. In today's world, there is a need for women to enter the workplace due to various reasons; financial needs, self-actualization, etc. This leaves the children either feeding for themselves or under the care of their elder siblings or elderly care takers, consumption of ready to eat foods which are convenient is increasing.
In a study conducted by Srivastava et al (2012) in Bareilly district showed higher risk of malnutrition in school-aged children whose mother had a service or business.

Hence, there is a need to fill the gap with easy to prepare/ ready to eat foods that are convenient, nutrient dense, affordable and made with ingredients that aim at improving the dietary diversity of the children. Premix possess all of the mentioned properties as they can be easily reconstituted and cooked as per need and convenience.

Premix is defined as "A substance or product consisting of ready-mixed materials." or "A mixture of ingredients designed to be mixed with other ingredients before use." Premixes when manufactured using food items belonging to various food groups so that they are a wholesome meal in themselves can help in increasing nutrient intake and improving dietary diversity among preschoolers.

Development of multigrain premixes and their incorporation in recipes which can be included in diet of pre-schoolers is found to be beneficial as it aids in reducing prevalence and development of undernutrition.

Shilpa Guddad and Pushpa Bharati (2014) developed a multigrain premix with ragi, rice, wheat, green gram dhal, soybean, groundnut, garden cress seeds and carrot shreds as ingredients. The premixes were incorporated in Ladoo and Thepla recipes and subjected to sensory evaluation by preschool children, Anganwadi workers, health care staff and mothers. The products were liked by 100% of the consumers and had increased levels of protein, iron, calcium and vitamins.
Prasad et al (2016) developed four versions of cereal (wheat) - pulse (green gram) premix along with potato and spinach leaves powder for malnourished children and incorporated them in five recipes – Panjiri, mathi, seviyan, biscuits and pinni. All the five recipes were accepted at 30% potato flour and 2.5% spinach flour composition of the premix.

Sethy and Mogra (2017) conducted a study wherein ready to cook Dalia mixes were formulated for preschool children. Four premixes were developed using different proportions of wheat

grits, sorghum grits, pearl millet grits, green gram dal, masoor dal, amaranth grain, groundnut grits and finger millet grits. Dalia made from all the premixes were found to be accepted well.

Mridula et al (2015) developed quick cooking dalia premixes using different proportions of barley, sorghum and pearl millet, the overall sensory acceptability of these premixes ranged between 7.50 to 8.49. The premixes were rich in crude fibre, calcium and iron along with low cooking time. The studies mentioned above utilise millets like sorghum (jowar), pearl millet (bajra), amaranth and finger millet (ragi) in the premixes because of their excellent nutritional properties.

Millets are a group of cereals that are widely grown around the world, they are present in the form of small seeded grass. Millets are favourable crop due to their ability to be cultivated in dry and high temperature conditions with limited water sources and less or no use of fertilizers. They are often called as ‘coarse grains’ or ‘poor man’s crop’ though they are excellent sources of energy, protein, vitamins and minerals (Table 2.2). Millets are also rich in phytochemicals which have anti-oxidant, anti-inflammatory and anti-thrombotic properties and thus provide against various non-communicable diseases.

Millets are classified into three categories:

- Major millets – Bajra (Pearl millet), Jowar (Sorghum) and Ragi (Finger millet)
- Minor millets – Kanj (Foxtail millet), Kodari (Kodo millet), Sanwa (Barnyard millet), Chenno (Proso millet) and Kutki (Little millet)
- Pseudo millets – Rajgira (Amaranth) and Kuttu (Buckwheat)

TABLE 2.2: NUTRITIONAL COMPOSITION OF MAJOR MILLETS

(per 100g)

	Kanj (Foxtail millet)	Bajra (Pearl millet)	Ragi (Finger millet)	Kanj (Foxtail millet)	Kodari (Kodo millet)	Sanva (Barnyard millet)	Chenno (Proso millet)	Kutki (Little millet)	Rajgira (Amaranth)	Kuttu (Buck-wheat)
Energy (kcal)	334	348	321	331	332	307	341	346	356	323
Carbohydrate (g)	67.7	61.8	66.8	60.9	66.2	65.5	70.4	65.5	61.5	65.1
Protein (g)	10.0	11.0	7.2	12.3	8.9	6.2	12.5	10.1	13.3	10.3
Fat (g)	1.73	5.4	1.9	4.3	2.5	2.2	1.1	3.9	5.6	2.4
Iron (mg)	3.95	6.4	4.6	2.8	2.3	5.0	0.8	1.2	8.0	15.5
Calcium (mg)	27.6	27.3	364	31	15.3	20.0	14.0	16.1	162	
Vitamin A (mcg)	1.38	4.7	0.3	1.38	4.7	0.3	-	-	-	

Source: Indian Food Composition Tables, NIN.

Following are the millets that have been used extensively in development of premixes for children under five years of age:

1. Jowar (Sorghum)

Jowar is a widely famous millet in terms of production and consumption. It is grown widely in Maharashtra, Uttar Pradesh, Madhya Pradesh, Haryana, Karnataka, Tamil Nadu, Andhra Pradesh, Telangana and some parts of Rajasthan. Jowar ranks fifth in cereal production on a global level while in India it holds the fourth position. It is a summer crop which is resistant to diseases and pests. Jowar is a great source of protein, fibre, folic acid, calcium, iron, thiamine, B-carotene, riboflavin and phosphorus.

In a study conducted in Andhra Pradesh by Lakshimidevi et al, jowar was supplemented to school children for 45 days as a part of mid-day meal programme, which resulted in significant weight gain, lower nutritional deficiency symptoms and morbidity patterns in children belonging to the experimental group.

Bahwere et all (2017) conducted a study on soy, maize and jowar based read to use therapeutic food (RUTF) for treatment of severe acute malnutrition in children below five years of age, the product was found to effective in the treatment even without addition of milk. The RUTF also aided in correcting iron deficiency anaemia.

2. Bajra (Pearl millet)

Bajra has been cultivated in India and Africa since ancient period. In India, Rajasthan, Haryana and Gujarat are the states where it is grown widely. Bajra can be cultivated in poorly nourished soil, in areas of low rainfall. It is a great source of various nutrients like B-complex vitamins, iron, magnesium, copper, vitamin E, folic acid and zinc. It is also rich in calcium and is energy dense as compared to other millets.

In a study conducted by Bansal and Kawatra (2020), Bio fortified bajra was incorporated into a traditional recipe (gulgule) for children. All the variants of the bajra incorporated snack were well accepted in terms of organoleptic attributes by children between 7-9 years of age. 50 grams of the variant -2 snack provided 1/4th RDA of calcium, zinc and iron for the children.

Arokiamary et al (2020) conducted a study where it was concluded that bajra based supplementary food increased biochemical parameters (haemoglobin, serum retinol and serum protein) and cognitive development among school children (5-6-years)

In a study done by Shekhawat et al (2019) in Bikaner, it was found that biscuits made from bajra and moth bean premix were able to increase haemoglobin levels and body weigh in undernourished young children (4-6 years) after 75 days of consumption.

3. Ragi (Finger millet)

Ragi is a short plant which bears small reddish seeds. It is grown all-round the year in dry regions of India. It is cultivated mostly in the southern states of the country. Ragi is infamous for its calcium content. It is also a rich source of vitamin A, phosphorus and Vitamin B and dietary fibre. Ragi is an excellent source of protein especially essential amino acids, thus it can aid in treatment of malnutrition.

In a study done by Rosy et al (2017), low cost nutrient dense supplementary product (laddo) was prepared from locally available grains which had ragi flour as the main ingredient. The ladoo made from the multigrain mixture was well accepted organoleptically and had higher percentage of nutrients when compared with cost range of Rs. 2.83 to 3.4.

In a study conducted by Lande et al (2017), development of nutrient rich vermicelli with malted ragi flour was done. It was found that the vermicelli variant which had wheat flour and malted ragi flour ration in 70:30 ratios had similar sensory score as the one made from 100% wheat flour. The calcium, iron and phosphorus levels were 30% higher for the ragi flour incorporated vermicelli comparatively.

Karkada et al (2018) studied effect of ragi porridge on haematological parameters of adolescent school going girls and concluded that consumption of ragi porridge for 90 days cause a significant increase in their haemoglobin levels.

4. Kodari (Kodo millet)

Cultivation of Kodari was started in India almost 3000 years ago. It is a perennial plant with light red to dark grey grains. Kodari has high protein content and low fat. Amongst all the millets, Kodari has the highest amount of dietary fibre. Another nutritional excellence of this millet involves high levels of niacin, folic acid, iron, magnesium, calcium, zinc and potassium. This millet is rich in lecithin which aids in nervous system development and strengthening.

In a study done by Neelam et al (2013), Glycemic index of products made from Kodo millet was evaluated. It was observed that Kodo based Idli and Sevai upma had significantly lower GI when compared to the traditional cereal based counterparts of the dishes.

Hegde and Chandra (2015) stated that Kodo millet had higher anti-oxidant property (free-radical quenching capacity) compared to other millets like Kanj (Foxtail millet), Jowar (Sorghum), Ragi (Finger millet) and Kutki (Little millet).

5. Rajigira (Amaranth)

Amaranth is grown widely in Kerala, Maharashtra, Telangana, Tamil Nadu and Andhra Pradesh. It has higher protein content, along with amino acid lysine which is a limiting amino acid of many grains. Amaranth is low in fat as compared to other cereal and millets and contains higher proportion of unsaturated fatty acids. It is rich in phytochemicals that show cholesterol-lowering, cancer- preventive and antihypertensive properties. It is a rich source of iron, potassium, phosphorus, magnesium and dietary fibre.

In a study done by Orsango et al (2020), Amaranth incorporated bread showed desirable effect on haemoglobin concentration in children with anaemia.

Okoth (2020) studied effect of amaranth-jowar grains inclusion in complementary feeds of children between 6-23 months of age in Kenya. The study concluded that the group that consumed amaranth-jowar grains had increased nutrient intake and had a higher chance of meeting their recommended daily nutrient allowance thus aiding to reducing incidences of chronic undernutrition among children below 2 years of age.

Along with millets, other grains like cereals, legumes, pulses, etc are used to develop the multigrain premixes it increases the protein quality. Whole wheat is cultivated worldwide and is staple food of many countries. It is the second most cultivated cereal after maize. In India, it is widely produced in Punjab, Uttar Pradesh, Madhya Pradesh and Haryana.

Wheat is a rich source of carbohydrates which is the preferred energy yielding nutrient of the body. It has protein content of 13%, though protein quality id low due to low content of essential amino acids. Whole wheat is also a greate sources of many micronutients like managanese, niacin , phosphorus and dietary fibre. Other phytochemicals found in wheat are ferulic acid, lignans, alkylresorcinols which are potent anti-oxidants.

In a study done by Engle-Stone et al (2017) it was concluded that fortified wheat flour can increase the iron, zinc, folate and vitamin B12 levels in women and children (1-5 years) after a year of supplemetation.

In another review study conducted by Ludmila et all (2017), it was found that the bioactive phenolic compounds present in the bran part of wheat, especially ferulic acid has high antioxidant properties that prevents LDL-cholesteol oxidation and reduces oxidative damage to DNA and lipid membranes.

Soybean is a species of legume that is a native to the eastern regioon of asian continent and has been appreciated for its high protein content and source of good quality fat.

It is an excellent source of minerals like manganese, phosporus, magnesium, potassium and B vitamins like folic acid and vitamin K. The protein content of soybean is high however it also has high amounts of protease inhibitors which can be reduced by cooking it well. Unfermented products of soybean like soy milk, tofu and feremnted products like soy sauce, bean paste, natto and tempeh has less to minimal amounts of protease inhibitors. Soybean has been recommended as a sunstitute of protein sources for vegetarians and vegans who do no include animal protein sources in their diet as the Protein Dogestbility Corrected Amino Acid Score (PDCAAS) of soybean is equivalent to that of meat, eggs and milk caesin. Soybean is a rich souce of PUFA mainly linoleic acid. Other constituents of soybean include isoflavones which are polyphenolic compounds which are similar to the antioxidants flaconoids found in other vegetables. Isoflavones present in soybean are a class of phytoetrogen that help in alleviating menopause symptoms.

In a study done by Jiao Xu et al (2019), that supplemetation of fortified soybean powder helped in reducing iron deficiency anemia in infants and young children along with significant decrease in prevalence of stunting, wasting and underweight.

Another study done by Al-Subhi (2020), that extruded snack products for children made from defaated soybean flour (40-30%) along with blend corn and spinach were most liked by the taste panellists.

Germination or fermentation along with roasting method was found to enhance nutritional value (energy, protein, zinc, iron, magnesium, phosphorus, B-carotene) of soybean flour fortified maize-millet complementary food. This conclusion was drawn in a study conducted by Akinsola et al (2017).

Vegetarian sources of protein especially cereals, millets, pulses and legumes are considered as incomplete sources because of lack of some essential amino acids which are known as limiting amino acids. Limiting amino acids for different food groups are mentioned as below:

- Cereals and millets : Lysine and Threonine
- Pulses : Methionine, Cystine and Tryptophan
- Beans/Legumes : Methionine

Thus, it is necessary to use vegetarian protein sources in combination with each other to ensure that all the essential amino acids are included in the diet. This is called as complementing protein sources.

In a study conducted by Anitha et al (2019), it was observed that acceptability of millet based dishes for mid day meal was high among adolescent school going children as compared to usual fortifed rice based dishes. The most liked dishes were combination of millets with cereals, pulses and lentils.

Millet based composite flour was developed by Tumwine et al (2019) for 6-59 months children. It was aboserved that addition of skim milk powder and vegetables significantly increased the macro and micro nutrient contents of the developed flours which could be used as supplementary feeds for the children and contritbute to improvement of their nutritional status.

Considering the prevalence of undernutrition among pre-schoolers, there is a need to address the issue of lack of dietary diversity in their diet. Premixes made from foods belonging to various food groups along with its incorporation into recipes which are accpetable and palatable would help in improving nutritional status of children belonging to this age group.

Rationale of the study:

There is a lack of nutrient dense premixes that would improve dietary diversity of preschoolers which would help in prevention of different forms of undernutrition.

Hence, the current study was planned to develop multigrain premixes and recipes from the premixes which would be subjected to sensory evaluation so as to aid in improvising the dietary diversity of home cooked meals given to preschoolers.

METHODS AND MATERIALS

Methods and Materials

Undernutrition among young children has been a topic of concern worldwide since a long time. Though the statistics for stunting and wasting has improved in last decade, there are still 144 million children affected one way or the other by undernutrition.

One of the strategies for prevention and management/treatment of undernutrition is feeding children nutritionally dense, dietary diverse meals which is achieved by including foods from most of the food groups in adequate quantities. Dietary diverse diet helps in ensuring sufficient supply of energy and nutrients (both macro and micro). For pre-schoolers, matching their nutritional requirements through a diverse diet is a difficult for their parents due to fuzzy eating behaviours of the children. Additionally, if both the parents are working, the diet of the children are more often dependant on convenient, easy to cook foods. Most of which that are available in the commercial market are nutritionally inadequate as they contain refined cereal, high amount of sugar, fat, additives and preservatives and most often artificial flavours and colours. These products are most commonly available in the form of premixes as they have a longer shelf life and easier to incorporate in meals. Thus, it is important to focus on making nutritionally dense and dietary diverse premixes available in market.

This study was determined on developing premixes that fulfils the energy and nutritional needs of pre-schoolers. The premix was make using millets, cereal and pulse as they complement each other's nutritional composition., for e.g. cereals have less amount of lysine and threonine which are found abundantly in pulses and legumes, similarly beans have methionine as a limiting amino acid and is balanced when consumed with cereals as they have methionine.

Millets were kept as the major ingredient in the premixes as they are rich sources of protein, micronutrient (like calcium, iron, phosphorus, etc) and phytochemicals. Millets also show high antioxidant properties as they contain phytates, polyphenols, anthocyanins, phytosterols and pinacosanols.

The study was approved by the Ethical committee of the Department of Foods and Nutrition, The Maharaja Sayajirao University of Baroda, Vadodara, Gujarat (IECHR/FCSC/2020/56)

The objectives of the study were as followed:

Broad Objective

To develop nutritionally dense premixes for improving dietary diversity among pre-schoolers.

Specific Objectives

1. To develop recipes from each of the multigrain premixes.
2. To carry out sensory evaluation tests of all the developed recipes.
3. To develop a multigrain premix recipe booklet.

Study design:

The present study was divided and carried out in 4 phases:

Phase I: Development and Standardization of Five Multigrain Premixes.

Phase II: Development and Standardization of Recipes made from the Multigrain Premixes.

Phase III: Sensory Evaluation of the Multigrain Premix Incorporated Recipes.

Phase IV: Development of a Multigrain Premix Incorporated Recipe Booklet

Phase I: Development and Standardization of Five Multigrain Premixes

The premixes were developed based on nutritional requirements of pre-schoolers and with an objective to introduce dietary diversity in their daily diet. The premixes were to be incorporated in recipes served during snack time. Thus, average of energy and nutrient requirements of children belonging to 3 years and 4-5 years' age groups was taken. The values were referred from the Nutrient Requirements for Indians: A Report of the Expert Group, 2020 by ICMR and NIN**.**

One fourth of those values were used to standardize the five premixes so that the premixes had similar caloric value and nutritional composition. The ingredients for the premixes was standardized to be in the calorie range of 100 to 110 kcal in one serving (30g).

Five premixes were decided to developed with wheat flour (8g) and soybean flour (8g) as the common ingredients. The varying ingredient were millets (15g). Four millet (Bajra, Jowar, Ragi and Kodari) and one pseudo millet (Amaranth) were used. (Figure 3.1)

The cereal, pulse/legumes and millets for the premixes were procured from the local market and grinded to flour in a local mill.

Following is the list of the five developed premixes:

1. Bajra premix – Bajra flour (15g), Wheat flour (8g) and Soybean flour (8g)

2. Jowar premix – Jowar flour (15g), Wheat flour (8g) and Soybean flour (8g)

3. Ragi premix – Ragi flour (15g), Wheat flour (8g) and Soybean flour (8g)

4. Kodari premix – Kodari flour (15g), Wheat flour (8g) and Soybean flour (8g)

5. Amaranth premix – Amaranth flour (15g), Wheat flour (8g) and Soybean flour (8g)

Phase II: Development and Standardization of Recipes made from the Multigrain Premixes

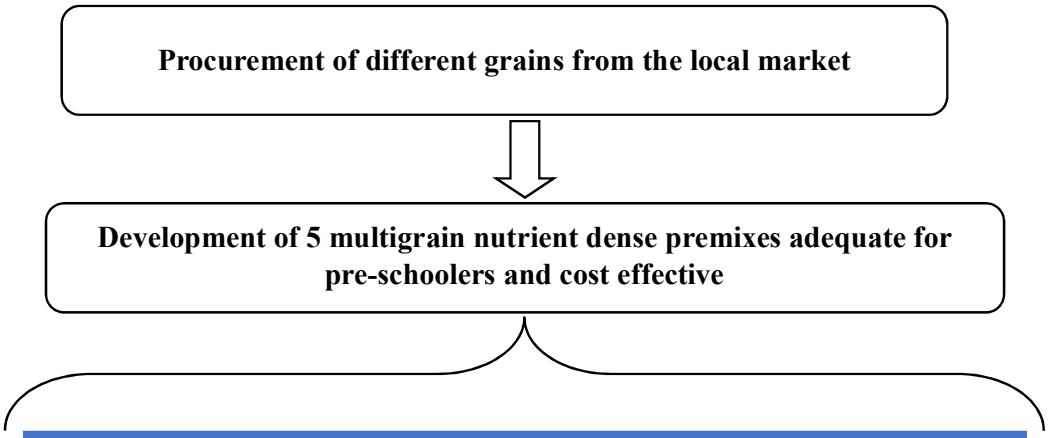
After development of the premixes, they were used to design recipes that fulfilled energy and nutritional requirements of pre-school children during snack time. Total of eight recipes were developed with keeping in mind to include most of the food groups to promote dietary diversity. The eight recipes were made using each premix, hence one recipe had five versions of it differing on the basis of the premix used. (Figure 3.2)

All the perishable and non-perishable ingredients were procured from local vegetable and grocery shops. All the fruits and vegetables were washed and cleaned before use and the seeds used were roasted beforehand.

List of the recipes developed from the premixes is as followed:

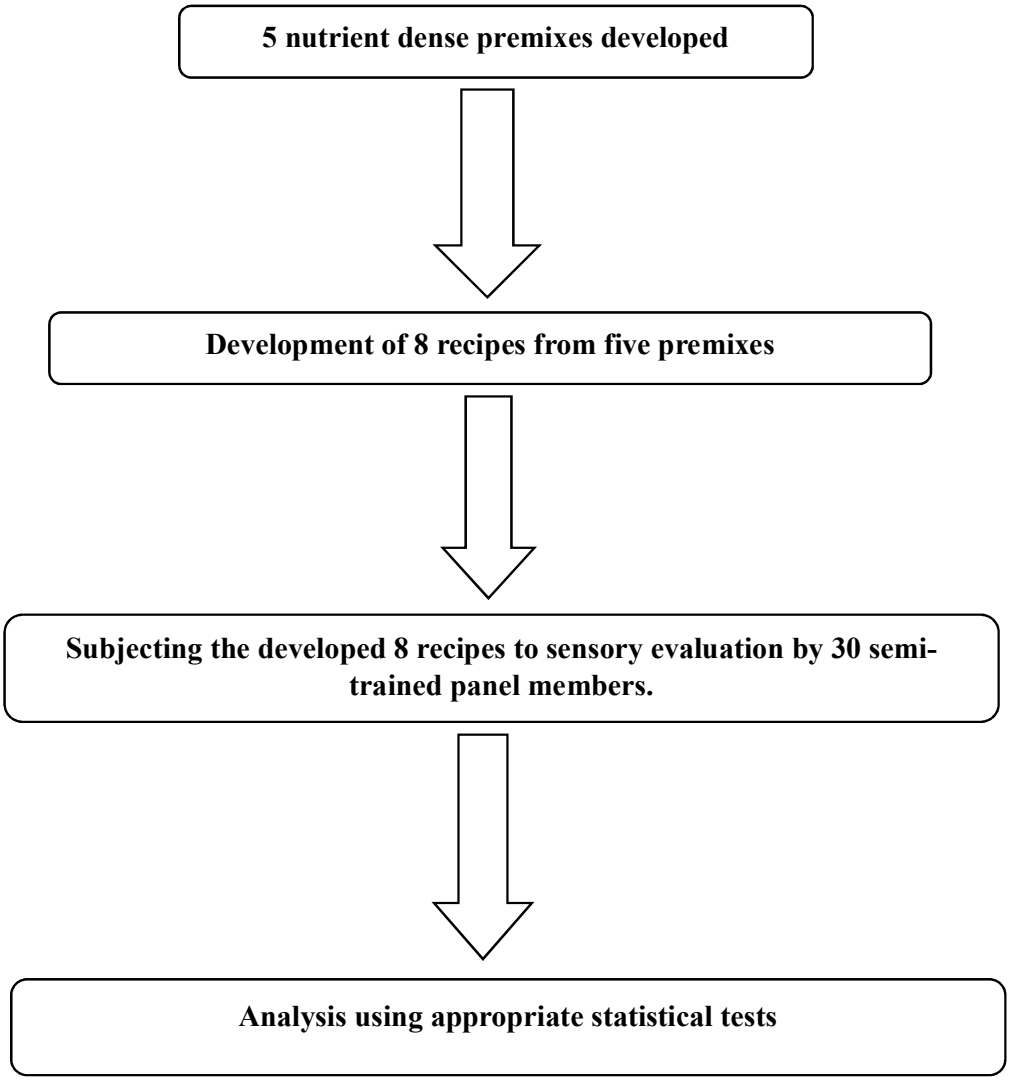
(a) Cheela
(b) Idli
(c) Thalipeeth
(d) Kothimbir vadi
(e) Tikki
(f) Handva
(g) Gud roti
(h) Seviyaan kheer

FIGURE 3.1: EXPERIMENTAL PLAN OF DEVELOPMENT AND STANDARDIZATION OF FIVE MULTIGRAIN PREMIXES.



PREMIXES	CEREAL	LEGUMES	MILLET
Bajra premix	Wheat (8g)	Soybean (8g)	Bajra (15g)
Jowar premix	Wheat (8g)	Soybean (8g)	Jowar (15g)
Ragi premix	Wheat (8g)	Soybean (8g)	Ragi (15g)
Kodari premix	Wheat (8g)	Soybean (8g)	Kodar (15g)
Amaranth premix	Wheat (8g)	Soybean (8g)	Amaranth (15g)

FIGURE 3.2. EXPERIMENTAL PLAN FOR DEVELOPMENT AND STANDARDIZATION OF RECIPES MADE FROM THE MULTIGRAIN PREMIXES.



PHASE III: Sensory Evaluation of Multigrain Premix Incorporated Recipes

Sensory evaluation of the developed and standardized recipes from five multigrain premixes namely; Cheela, Idli, Thalipeeth, Kothimbir vadi, Tikki, Handva, Gud roti, Seviyaan kheer was carried out with a panel of 30 semi-trained panellists from the Faculty who gave their consent to participate in the study for the sensory evaluation (Appendix I).

A baseline data on the general information, medical or medication history was taken using a Google Form on the basis of which the panellists were selected. The 30 semi-trained panellist members were asked to rate each attributes of the developed recipes using a Google form. It consisted of two parts: Composite rating scale and overall liking of recipes using the Hedonic rating test. Due to the ongoing pandemic, all the precautionary measures were taken while carrying out the sensory evaluation. Therefore, Google form was given to the panellists to minimize the contact so as to taste and rate the developed recipes.

Composite Rating Scale: The 10 point scoring test was conducted so that the specific characteristics of the product could be rated separately. It helps to point out which specific attribute is not acceptable or is at fault.

All the developed recipes were evaluated for the following attributes:

- Colour & Appearance
- Aroma
- Texture
- Taste
- After taste
- Mouth feel
- Overall acceptability

Hedonic Rating Test: This test has a 7-point rating scale ranging from ‘like very much’ to ‘dislike very much’ with ‘neither like nor dislike’ as the middle score that helped in identifying the most or least liked product from the various recipes.

The specific attributes studied for each of the products is mentioned in Appendix I. The flow chart for sensory evaluation is given in Figure.

Inclusion criteria for sensory evaluation panellists:

- The subjects must have
- sound health without any defects in sensory perception

- interest in quality evaluation work
- availability and willingness to spend time in evaluation
- freedom from prejudices with respect to a particular food product

Exclusion criteria for sensory evaluation panellists:

- The subjects who smokes,
- tend to consume alcohol
- any type of allergies
- undergone any recent surgeries
- taking any sort of medications that may impact the sensory attributes and
- not willing to take part in the study are to be excluded.

The tools and techniques used for data collection are shown in Table 3.1.

Phase IV: Development of a Multigrain Premixes Incorporated Recipes Booklet.

The information about the developed multigrain premixes and the recipes there were incorporated in was documented and a booklet was curated which would help in promoting the use of these premixes in the diet of pre-schoolers and ultimately would lead to increase in dietary diversity among them and improvement in their nutritional status. (Appendix III)

The booklet contains information about the following topics:

- Pre-schoolers and importance of dietary diversity among them
- Introduction of the five multigrain premixes
- List of the multigrain premixes incorporated recipes
- Ingredients used
- Cooking instruction
- Nutrient composition table

Statistical Analysis:

The data collected from the Composite rating tests and Hedonic tests were entered into Microsoft Excel spreadsheets. Various statistical tests were subjected after data collection and entry was completed. Following are the list of statistical tests used for analysis of the data:

- ANOVA single factor test (‘F’ test)
- Unpaired ‘t’ test with equal variance

TABLE 3.1: TOOLS AND TECHNIQUES

PARAMETERS	METHODS/TOOLS
General Information of Semi-Trained Panellists	Pretested Questionnaire (Google Form)
Sensory Attributes	Composite Rating Scale (Google Form)
Sensory Attributes	Hedonic Rating Test (Google Form)

RESULTS AND DISCUSSION

Results

Children belonging to pre-school age group (3-5 years) are a vulnerable group for development of undernutrition and micronutrient deficiencies. Introduction of dietary diversity to daily diet has been found to improve the nutritional status of pre-schoolers as it ensures adequate supply of nutrients according to their requirements. In this study, five multigrain premixes were developed and incorporated into eight recipes where efforts were made to incorporate foods from almost all the food groups with an aim to increase the dietary diversity among pre-schoolers.

The study was carried out with an objective to develop nutritionally dense premixes for improving dietary diversity among pre-schoolers and to develop recipes in which the developed premixes can be incorporated and to conduct sensory evaluation of the premix incorporated recipes.

The results of the study are discussed under four phases:

Phase I: Development and Standardization of Five Multigrain Premixes.

Phase II: Development and Standardization of Recipes made from the Multigrain Premixes.

Phase III: Sensory Evaluation of the Multigrain Premix Incorporated Recipes.

Phase IV: Development of a Multigrain Premix Incorporated Recipe Booklet

Phase 1: Development and Standardization of Five Multigrain Premixes.

To increase the dietary diversity of children belonging to the pre-school age group, it is important to include variety of food groups in their daily diet. As this age group is in a rapid growth period, both mentally and physically, it is important to fulfil their daily nutrient requirements to prevent the development of undernutrition and micronutrient deficiencies. The premix incorporated recipes were developed with the intention of fulfilling $1/4^{th}$ of the EAR of Indian preschool children (Table 4.1) The five multigrain premixes in this study were designed to include three food groups – Cereals, Millet and Legume. The cereal used was wheat and the legume used was soybean which were common in all the five premixes. Four millets - bajra,

jowar, ragi and kodari and one pseudo-millet (Amaranth) were used which were the variable ingredients.

The nutrient composition of the premixes on an average was found to be 106 ± 1.95 kcal energy, 15.66 ± 0.44g carbohydrate, 5.38 ± 0.34 g protein and 2.18 ± 0.28 g fat (Table 4.2). The cost of the developed premixes ranged between Rs. 1 – 2 per serving (30g).

Phase II: Development and Standardization of Recipes made from the Multigrain Premixes.

Eight recipes were developed and standardized from each of the five multigrain premixes that were developed. The eight recipes developed from each of the premixes were Cheela, Idli, Thalipeeth, Kothimbir vadi, Tikki, Handva, Gud roti and Seviyaan kheer. The average nutrient content (Tables 4.3 – 4.10) of the recipes made from the developed premixes ranged between 297 to 324 kcal for energy, 24.8 to 35.7g for carbohydrates, 6.9 to 13.9g for protein, 11.9 to 19.8g fat, 2.4 to 6.5mg iron, 67 to 314mg calcium and 3.2 to 410.2 mcg vitamin A. The cost of the recipes made using the developed multigrain premixes ranged between Rs. 8 – 12 per serving.

Phase III: Sensory Evaluation of the Multigrain Premix Incorporated Recipes

In this phase, the results of the sensory evaluation of the recipes made from different premixes is discussed as follow –

i. Composite test score comparison of individual recipes made using different multigrain premixes.
ii. Composite test score comparison of different recipes made using the same multigrain premixes.
iii. 7-point Hedonic test score comparison of individual recipes made using different multigrain premixes.
iv. 7-point Hedonic test score comparison of different recipes made using the same multigrain premixes.
v. Serving size sufficiency of the recipes made from the developed multigrain premixes.

For both of these methods, the scores were compared using statistical tests like Mean, Standard deviation, ANOVA (single factor) and student's t test.

Phase IV: Development of a Multigrain Premixes Incorporated Recipes Booklet.

The information about the developed multigrain premixes and the recipes there were incorporated in was documented and a booklet was curated which would help in promoting the use of these premixes in the diet of pre-schoolers and ultimately would lead to increase in dietary diversity among them and improvement in their nutritional status (Appendix III).

The booklet contains information about the following topics:

- Pre-schoolers and importance of dietary diversity among them
- Introduction of the five multigrain premixes
- List of the multigrain premixes incorporated recipes
- Ingredients used
- Cooking instruction
- Nutrient composition table

TABLE 4.1 ESTIMATED AVERAGE REQUIREMENT OF INDIAN PRE-SCHOOLERS

Age	Energy (Kcal/d)	Carbohydrate (g/d)	Protein (g/d)	Fat (g/d)	Iron (mg/d)	Calcium (mg/d)	Vitamin A (mcg/d)
3 years	1010	100	9.2	25	6	400	180
4-5 years	1360	100	12.8	25	8	450	240
One fourth of EAR:							
3 years	253	25	2.3	6.3	1.5	100	45
4-6 years	340	25	3.2	6.3	2	113	60
Average	296.5~ 300	25	2.8	6.3	1.75	107	52.5

Table 4.2: NUTRIENT COMPOSITION OF MULTIGRAIN PREMIXES.

Multigrain premixes	Energy (kcal)	Carbohydrate (g)	Protein (g)	Fat (g)	Iron (mg)	Calcium (mg)	Vitamin A (mcg)
Bajra premix	108	15.21	5.51	2.48	1.95	22	0.79
Jowar premix	106	16.09	5.37	1.93	1.58	22	0.29
Ragi premix	104	15.96	4.94	1.96	1.68	73	0.12
Kodari premix	106	15.87	5.21	2.05	1.34	20	0.12
Amaranth premix	109	15.16	5.86	2.5	2.19	42	0.08
Mean ± SD	107±1.95	15.66 ± 0.44	5.38 ± 0.34	2.18 ± 0.28	1.75 ± 0.33	35.80 ± 22.65	0.28 ± 0.30

Table 4.3: NUTRIENT COMPOSITION OF THE CHEELA MADE FROM DIFFERENT PREMIXES.

Variations	Energy (Kcal)	Carbohydrate (g)	Protein (g)	Fat (g)	Iron (mg)	Calcium (mg)	Vitamin A (mcg)
Bajra premix	326	24.4	10.9	20.1	4.8	206	98.2
Jowar premix	324	25.3	10.7	19.6	4.5	206	97.7
Ragi premix	322	25.1	10.3	19.6	4.6	257	97.5
Kodari premix	324	25.1	10.6	19.7	4.2	203	99.2
Amaranth premix	327	24.3	11.3	20.2	5.1	225	99
Mean ± SD	325 ± 1.95	24.84 ± 0.46	10.76 ± 0.37	19.84 ± 0.29	4.64 ± 0.34	219.40 ± 22.77	98.32 ± 0.76

Table 4.4: NUTRIENT COMPOSITION OF THE IDLI MADE FROM DIFFERENT PREMIXES.

Variations	Energy (Kcal)	Carbohydrate (g)	Protein (g)	Fat (g)	Iron (mg)	Calcium (mg)	Vitamin A (mcg)
Bajra premix	298	35.3	10.4	12.4	4.7	118	94.1
Jowar premix	296	36.2	10.2	11.8	4.4	118	93.6
Ragi premix	294	36	9.8	11.86	4.5	169	93.4
Kodari premix	296	36	10.1	11.9	4.1	115	95
Amaranth premix	299	35.2	10.8	12.4	5	137	94.9
Mean ± SD	297 ± 1.95	35.74 ± 0.46	10.26 ± 0.37	12.07 ± 0.30	4.54 ± 0.34	131.40 ± 22.77	94.20 ± 0.73

Table 4.5: NUTRIENT COMPOSITION OF THALIPEETH MADE FROM DIFFERENT PREMIXES.

Variations	Energy (Kcal)	Carbohydrate (g)	Protein (g)	Fat (g)	Iron (mg)	Calcium (mg)	Vitamin A (mcg)
Bajra premix	308	24.3	13.5	17	6.7	301	410.1
Jowar premix	306	25.2	13.4	16.4	6.3	301	409.6
Ragi premix	304	25	12.9	16.5	6.4	352	409.4
Kodari premix	306	25	13.2	16.6	6.1	298	411
Amaranth premix	302	24.2	13.9	17	6.9	320	411
Mean ± SD	305 ± 2.28	24.74 ± 0.46	13.38 ± 0.37	16.70 ± 0.28	6.48 ± 0.32	314.40 ± 22.77	410.22 ± 0.76

Table 4.6: NUTRIENT COMPOSITION OF TIKKI MADE FROM DIFFERENT PREMIXES.

Variations	Energy (Kcal)	Carbohydrate (g)	Protein (g)	Fat (g)	Iron (mg)	Calcium (mg)	Vitamin A (mcg)
Bajra premix	296	32.4	13	12.2	4.5	167	121.2
Jowar premix	294	33.3	12.9	11.6	4.1	167.1	120.7
Ragi premix	292	33.2	12.4	11.7	4.2	218	120.5
Kodari premix	294	33.1	12.7	11.7	3.8	164	122.1
Amaranth premix	297	32.3	13.4	12.2	4.7	186	122
Mean ± SD	295 ± 1.95	32.86 ± 0.47	12.88 ± 0.37	11.88 ± 0.29	4.26 ± 0.35	180.42 ± 22.75	121.30 ± 0.73

Table 4.7: NUTRIENT COMPOSITION OF KOTHIMBIR VADI MADE FROM DIFFERENT PREMIXES.

Variations	Energy (Kcal)	Carbohydrate (g)	Protein (g)	Fat (g)	Iron (mg)	Calcium (mg)	Vitamin A (mcg)
Bajra premix	304	29.6	10.3	15.5	4.3	120.7	128.2
Jowar premix	302	30.5	10.2	14.9	3.9	120.7	127.7
Ragi premix	300	30.4	9.7	15	4	171.7	127.6
Kodari premix	302	30.3	10	15.1	3.7	117.7	129.1
Amaranth premix	305	29.5	10.7	15.6	4.6	139.7	129
Mean ± SD	303 ± 1.95	30.06 ± 0.47	10.18 ± 0.37	15.22 ± 0.31	4.10 ± 0.35	134.10 ± 22.77	128.32 ± 0.70

Table 4.8: NUTRIENT COMPOSITION OF GUD ROTI MADE FROM DIFFERENT PREMIXES.

Variations	Energy (Kcal)	Carbohydrate (g)	Protein (g)	Fat (g)	Iron (mg)	Calcium (mg)	Vitamin A (mcg)
Bajra premix	304	30.1	7.1	16.6	2.7	53.4	3.11
Jowar premix	302	30.9	6.9	16.4	2.3	53.3	2.61
Ragi premix	300	30.8	6.5	16.4	2.43	104.3	2.4
Kodari premix	302	30.7	6.8	16.5	2.1	50.3	4
Amaranth premix	305	30	7.5	17	2.9	72.3	3.9
Mean ± SD	303 ± 1.95	30.50 ± 0.42	6.96 ± 0.37	16.58 ± 0.25	2.49 ± 0.32	66.72 ± 22.75	3.20 ± 0.73

Table 4.9: NUTRIENT COMPOSITION OF HANDVA MADE FROM DIFFERENT PREMIXES.

Variations	Energy (Kcal)	Carbohydrate (g)	Protein (g)	Fat (g)	Iron (mg)	Calcium (mg)	Vitamin A (mcg)
Bajra premix	323	34.66	12.92	14.11	3.97	145.66	7.21
Jowar premix	321	35.54	12.78	13.56	3.6	145.66	6.71
Ragi premix	319	35.41	12.35	13.59	3.7	196.66	6.54
Kodari premix	321	35.32	12.62	13.68	3.36	142.26	8.08
Amaranth premix	324	34.55	13.31	14.13	4.21	164.66	8.04
Mean ± SD	321 ± 1.95	35.10 ± 0.46	12.80 ± 0.36	13.81 ± 0.28	3.77 ± 0.33	158.98 ± 22.84	7.32 ± 0.72

Table 4.10: NUTRIENT COMPOSITION OF SEVIYAAN KHEER MADE FROM DIFFERENT PREMIXES.

Variations	Energy (Kcal)	Carbohydrate (g)	Protein (g)	Fat (g)	Iron (mg)	Calcium (mg)	Vitamin A (mcg)
Bajra premix	312	34.5	10.68	14.24	2.61	204.18	4.25
Jowar premix	310	35.38	10.54	13.69	2.24	204.18	3.75
Ragi premix	308	35.25	10.11	13.72	2.34	255.18	3.58
Kodari premix	310	35.16	10.38	13.81	2	200.78	5.12
Amaranth premix	313	34.39	11.07	14.26	2.85	223.18	5.08
Mean ± SD	311 ± 1.95	34.94 ± 0.46	10.56 ± 0.36	13.94 ± 0.28	2.41 ± 0.33	217.50 ± 22.84	4.36 ± 0.72

i. Composite test score comparison of individual recipes made using different multigrain premixes.

1. Cheela:

The composite rating score of cheela developed from different premixes indicated that with respect to attributes like aroma, texture, taste, aftertaste, mouthfeel and overall acceptability no significant difference was observed when statistical test of ANOVA was carried out (Table 4.11). Only in the attribute of colour and appearance a significant difference was observed ($p < 0.01$). The unpaired 't' test run between the cheela recipe made from different premix for the attribute of colour and appearance indicated that there was significant difference ($p < 0.05$) between Bajra and Jowar, Bajra and Kodari, Bajra and Amaranth, Ragi and Kodari.

2. Gud Roti

For this recipe as depicted in table 4.12, there was a significant difference ($p < 0.05$) seen for all the attributes after conducting statistical test of ANOVA. Further unpaired 't' test was applied on the scores of all the attribute wherein for colour and appearance attribute, significant difference ($p < 0.05$, $p < 0.01$) was found between Bajra and Ragi, Bajra and Kodari, Bajra and Amaranth, Jowar and Ragi, Jowar and Amaranth while highly significant ($p < 0.001$) difference was found between Ragi and Kodari, Ragi and Amaranth.

With respect to aroma attribute, significant difference ($p < 0.05$, $p < 0.01$) was seen between Bajra and Kodari, Bajra and Amaranth, Jowar and Kodari, Jowar and Amaranth while between Ragi and Kodari, Ragi and Amaranth the differences were highly significant ($p < 0.001$).

For texture, significant difference ($p < 0.05$, $p < 0.01$) was observed between Bajra and Amaranth, Jowar and Amaranth, Ragi and Amaranth, Kodari and Amaranth. As for taste the differences between Bajra and Kodari, Jowar and Kodari, Ragi and Kodari were significant ($p < 0.05$, $p < 0.01$) while highly significant difference ($p < 0.001$) was observed between Bajra and Amaranth, Jowar and Amaranth, Ragi and Amaranth.

TABLE 4.11: COMPOSITE RATING SCORES FOR CHEELA MADE FROM DIFFERENT PREMIXES

Attributes	Bajra Premix (B)	Jowar Premix (J)	Ragi Premix (R)	Kodari Premix (K)	Amaranth Premix (A)	'F' value	p value
Colour and Appearance	7.80 ± 0.85	8.30 ± 0.84	7.83 ± 1.09	8.50 ± 0.86	8.30 ± 0.79	3.69	0.007**
Aroma	8.23 ± 0.86	8.20 ± 1.03	8.23 ± 1.07	8.27 ± 0.91	8.20 ± 0.85	0.03	0.99
Texture	8.13 ± 0.68	8.33 ± 0.92	7.97 ± 0.89	8.30 ± 0.99	8.33 ± 0.76	1.06	0.38
Taste	8.13 ± 1.01	8.63 ± 0.81	8.00 ± 1.14	8.30 ± 1.02	8.23 ± 1.10	1.61	0.17
After Taste	7.83 ± 0.87	8.37 ± 0.72	7.80 ± 1.03	8.23 ± 0.97	8.00 ± 0.91	2.24	0.07
Mouthfeel	8.03 ± 0.96	8.37 ± 0.89	7.77 ± 1.22	8.33 ± 0.92	8.17 ± 0.75	1.95	0.105
Overall Acceptability	8.00 ± 0.79	8.43 ± 0.77	8.03 ± 1.13	8.40 ± 0.89	8.27 ± 0.94	1.46	0.22
Total Score	56.17 ± 4.69	58.63 ± 4.66	55.63 ± 6.48	58.33 ± 5.28	57.50 ± 4.45		

p value of unpaired 't' test (equal variance) of significantly different attributes of Cheela made from different premixes

	B vs J	B vs R	B vs K	B vs A	J vs R	J vs K	J vs A	R vs K	R vs A	K vs A
Colour and Appearance	0.025*	0.89	0.002**	0.022*	0.0672	0.37	1	0.01*	0.062	0.354

* Significant difference at $p < 0.05$

** Significant difference at $p < 0.01$

*** Highly significant difference at $p < 0.001$

TABLE 4.12: COMPOSITE RATING SCORES FOR GUD ROTI MADE FROM DIFFERENT PREMIXES

Attributes	Bajra Premix (B)	Jowar Premix (J)	Ragi Premix (R)	Kodari Premix (K)	Amaranth Premix (A)	'F' value	P-value
Colour and Appearance	7.93 ± 1.05	8.00 ± 1.14	7.33 ± 1.15	8.47 ± 0.86	8.73 ± 0.98	8.00	0.00 ***
Aroma	8.00 ± 0.91	7.93 ± 1.01	7.63 ± 1.19	8.53 ± 0.68	8.60 ± 0.77	5.94	0.00 ***
Texture	8.07 ± 0.78	8.03 ± 1.00	7.97 ± 0.93	8.00 ± 0.74	8.61 ± 0.67	2.88	0.02 *
Taste	7.90 ± 1.16	8.10 ± 0.96	8.07 ± 0.91	8.63 ± 0.81	8.90 ± 0.80	6.20	0.00 ***
After Taste	7.77 ± 1.04	7.87 ± 1.01	7.70 ± 0.75	8.40 ± 0.72	8.00 ± 1.08	2.65	0.03 *
Mouthfeel	7.97 ± 1.03	8.00 ± 0.95	7.80 ± 0.76	8.43 ± 0.63	8.80 ± 0.92	6.62	0.00 ***
Overall Acceptability	8.17 ± 1.18	8.07 ± 1.08	7.77 ± 0.82	8.50 ± 0.86	9.03 ± 0.89	7.37	0.00 ***
Total scores	55.80 ± 4.90	56.00 ± 6.24	54.27 ± 5.48	58.97 ± 3.46	60.67 ± 3.38		

* Significant difference at $p < 0.05$

** Significant difference at $p < 0.01$

*** Highly significant difference at $p < 0.001$

p- value of unpaired 't' test (equal variance) of significantly different attributes of Gud roti made from different premixes

	B vs J	B vs R	B vs K	B vs A	J vs R	J vs K	J vs A	R vs K	R vs A	K vs A
Colour and Appear-ance	0.81	0.04 *	0.03 *	0.003 **	0.03 *	0.08	0.01 *	0.00 ***	0.00 ***	0.27
Aroma	0.79	0.18	0.01 *	0.008 **	0.29	0.009 **	0.005 **	0.00** *	0.00 ***	0.72
Texture	0.89	0.65	0.73	0.01 *	0.79	0.88	0.017 *	0.89	0.006 **	0.00 3**
Taste	0.47	0.54	0.006 *	0.00 ***	0.89	0.02 *	0.000 9***	0.01 *	0.00 ***	0.20
After taste	0.71	0.77	0.008 **	0.40	0.47	0.02 *	0.62	0.00 ***	0.21	0.09
Mouthf -eel	0.86	0.47	0.04 *	0.002 **	0.37	0.04 *	0.002 **	0.00 ***	0.00 ***	0.08
Overall Accepta -bility	0.73	0.13	0.21	0.002 **	0.23	0.09	0.00* **	0.001* *	0.00 ***	0.02 *

* Significant difference at $p < 0.05$

** Significant difference at $p < 0.01$

*** Highly significant difference at $p < 0.001$

With respect to aftertaste, significant difference ($p < 0.05$, $p < 0.01$) was observed between Bajra and Kodari, Jowar and Kodari while the difference between Ragi and Kodari was highly significant ($p < 0.001$).

For mouthfeel, the differences were significant ($p < 0.05$, $p < 0.01$) between Bajra and Kodari, Bajra and Amaranth, Jowar and Kodari, Jowar and Amaranth while it was highly significant ($p < 0.001$) between Ragi and Kodari, Ragi and Amaranth. As for overall acceptability highly significant difference ($p < 0.001$) was observed between Jowar and Amaranth, Ragi and Kodari, Ragi and Amaranth while there was significant difference ($p < 0.05$, $p < 0.01$) between Bajra and Amaranth, Kodari and Amaranth.

3. Handva

There was no significant difference observed in any of the attributes for Handva prepared from different premixes (Table 4.13). The scores for colour and appearance were similar except for Handva made with Ragi premix as seen in table 4.13. The same trend was seen for texture too. All the other attributes were scored 8 and above out of 10 which showed the higher acceptability of this recipe.

4. Idli

Idli showed no significant differences between the different attributes (Table 4.14). A seven and higher score was given for every attribute, for all the five premix variations which represents that all the idli variations were rated as above average. Kodari premix incorporated Idli had a slightly higher average total score comparatively. The similarity in the attributes score for all the groups indicate that each of the five premixes when used for this recipe produces the same outcome as far as sensory properties are concerned.

As vegetables like beetroot and carrot were used in this recipe, the colour and appearance was more influenced by them instead of the millet premix. The texture and mouthfeel was found to be similar for the idlis made from different premixes

5. Kothimbir vadi

Kothimbir vadi had no significant differences when its attributes were compared to each other as seen in table 4.15. All the attributes for all the five variations of premixes scored between 8-9 out of 10, which indicates higher acceptability and palatability of the recipe.

The average total scores of these variations are also alike, which makes it possible to use the premixes interchangeably for this recipe.

6. Seviyaan kheer

Seviyaan kheer made from Kodari premix has the highest rated colour and appearance while the same recipe made from Ragi premix had a lower score. There was a significant difference only in this particular attribute. The differences between the Bajra and Ragi, Bajra and Kodari, Jowar and Ragi, Ragi and Kodari, Ragi and Amaranth were significant ($p < 0.05$, $p < 0.01$) with respect to colour and appearance. Other attributes had similar scores. The average total score was lower for seviyaan kheer made from Ragi premix comparatively, while the one made with Kodari premix had the highest score (Table 4.16).

7. Thalipeeth

Significant differences ($p < 0.05$, $p < 0.01$) were seen in the colour and appearance between the thalipeeth made from Bajra and Ragi, Bajra and Kodari, Bajra and Amaranth, Jowar and Kodari. Thalipeeth prepared from Bajra and Kodari, Jowar and Ragi, Ragi and Kodari, Ragi and Amaranth had a highly significant difference ($p < 0.001$) between them as depicted in table 4.17. The Bajra and Kodari, Bajra and Amaranth, Ragi and Amaranth premix incorporated thalipeeth had significant difference ($p < 0.05$, $p < 0.01$) between their score for mouthfeel. With respect to overall acceptability, the difference was significant ($p < 0.05$, $p < 0.01$) between the Bajra and Kodari, Bajra and Amaranth premix groups while it was highly significant ($p < 0.001$) between the Ragi and Kodari, Ragi and Amaranth premix groups. Other attributes had similar scores of 8 and above indicating high acceptability.

8. Tikki

There was a significant difference found between the scores of colour and appearance, taste and aftertaste depicted in table 4.18. The difference in the colour and appearance scores between Bajra and Jowar, Bajra and Amaranth, Jowar and Ragi versions of the tikki were significant ($p < 0.05$, $p < 0.01$). There was a highly significant difference ($p <$

TABLE 4.13: COMPOSITE RATING SCORES FOR HANDVA MADE FROM DIFFERENT PREMIXES

Attributes	Bajra Premix (B)	Jowar Premix (J)	Ragi Premix (R)	Kodari Premix (K)	Amaranth Premix (A)	'F' value	P-value
Colour and Appearance	8.30 ± 1.18	8.30 ± 1.24	7.83 ± 1.26	8.33 ± 1.27	8.60 ± 1.25	1.49	0.21
Aroma	8.63 ± 1.00	8.60 ± 1.22	8.07 ± 1.28	8.30 ± 1.18	8.20 ± 1.27	1.30	0.28
Texture	8.50 ± 1.01	8.47 ± 1.07	7.80 ± 1.30	8.47 ± 1.11	8.30 ± 1.39	1.85	0.12
Taste	8.33 ± 1.35	8.43 ± 1.17	8.03 ± 1.16	8.50 ± 1.20	8.13 ± 1.59	0.69	0.60
After Taste	8.13 ± 1.14	8.43 ± 1.14	8.43 ± 1.14	8.40 ± 1.25	8.10 ± 1.81	0.49	0.74
Mouthfeel	8.50 ± 1.07	8.17 ± 1.08	8.17 ± 1.09	8.57 ± 0.94	8.23 ± 1.43	0.87	0.48
Overall Acceptability	8.47 ± 1.17	8.17 ± 1.05	8.13 ± 1.20	8.57 ± 1.07	8.27 ± 1.53	0.73	0.57
Total	58.87 ± 6.77	58.57 ± 6.86	56.47 ± 7.42	59.13 ± 7.26	57.83 ± 9.30		

TABLE 4.14: COMPOSITE RATING SCORES FOR IDLI MADE FROM DIFFERENT PREMIXES

Attributes	Bajra Premix (B)	Jowar Premix (J)	Ragi Premix (R)	Kodari Premix (K)	Amaranth Premix (A)	'F' value	P – value
Colour and Appearance	7.70 ± 0.95	7.93 ± 0.83	7.67 ± 1.06	8.10 ± 0.80	8.23 ± 0.97	2.12	0.08
Aroma	7.77 ± 1.22	7.90 ± 1.06	7.80 ± 1.06	7.93 ± 0.94	7.97 ± 1.16	0.19	0.94
Texture	7.50 ± 1.28	7.60 ± 1.16	7.90 ± 0.80	8.20 ± 0.66	7.83 ± 1.26	1.99	0.10
Taste	7.80 ± 1.13	7.80 ± 0.89	7.93 ± 0.78	8.17 ± 0.79	7.50 ± 1.11	1.94	0.11
After Taste	7.70 ± 1.02	7.80 ± 0.76	7.57 ± 0.90	8.03 ± 0.81	7.40 ± 1.07	1.94	0.11
Mouthfeel	7.83 ± 1.15	7.73 ± 0.91	7.63 ± 1.03	7.97 ± 0.85	7.50 ± 0.97	0.99	0.41
Overall Acceptability	7.93 ± 1.01	7.87 ± 0.82	7.83 ± 0.91	8.17 ± 0.70	7.63 ± 1.13	1.29	0.28
	54.23 ± 6.82	54.63 ± 5.39	54.33 ± 5.41	56.57 ± 4.07	54.07 ± 6.79		

TABLE 4.15: COMPOSITE RATING SCORES FOR KOTHIMBIR VADI MADE FROM DIFFERENT PREMIXES

Attributes	Bajra Premix (B)	Jowar Premix (J)	Ragi Premix (R)	Kodari Premix (K)	Amaranth Premix (A)	'F' value	P – value
Colour and Appearance	8.37 ± 1.22	8.53 ± 0.97	8.20 ± 1.56	8.73 ± 0.74	8.77 ± 0.86	1.42	0.23
Aroma	8.63 ± 1.30	8.40 ± 1.40	8.30 ± 1.32	8.60 ± 1.22	8.57 ± 1.10	0.38	0.82
Texture	8.27 ± 1.31	8.40 ± 1.13	8.33 ± 1.24	8.47 ± 0.86	8.60 ± 0.97	0.40	0.81
Taste	8.53 ± 1.25	8.60 ± 0.97	8.40 ± 1.28	8.53 ± 0.90	8.73 ± 0.83	0.39	0.81
After Taste	8.30 ± 1.15	8.33 ± 0.99	8.33 ± 1.24	8.53 ± 0.97	8.00 ± 1.20	0.88	0.48
Mouthfeel	8.47 ± 1.43	8.40 ± 1.04	8.30 ± 1.47	8.43 ± 1.01	8.47 ± 1.22	0.09	0.98
Overall Acceptability	8.40 ± 1.48	8.53 ± 1.01	8.60 ± 1.07	8.60 ± 0.81	8.47 ± 1.32	0.17	0.95
Total	59.90 ± 7.98	59.20 ± 6.62	58.47 ± 7.96	59.90 ± 5.11	59.60 ± 6.8		

TABLE 4.16: COMPOSITE RATING SCORES FOR SEVIYAAN KHEER MADE FROM DIFFERENT PREMIXES

Attributes	Bajra Premix (B)	Jowar Premix (J)	Ragi Premix (R)	Kodari Premix (K)	Amaranth Premix (A)	'F' value	P – value
Colour and Appearance	8.27 ± 0.98	8.33 ± 0.76	7.80 ± 0.81	8.50 ± 0.86	8.43 ± 0.90	3.05	0.01*
Aroma	8.43 ± 0.86	8.20 ± 0.85	8.00 ± 0.91	8.57 ± 0.94	8.40 ± 0.77	1.97	0.1
Texture	8.20 ± 0.81	8.30 ± 0.65	7.97 ± 0.85	8.47 ± 0.86	8.50 ± 0.86	2.15	0.07
Taste	8.33 ± 0.71	8.40 ± 0.72	8.07 ± 0.69	8.57 ± 0.97	8.40 ± 0.89	1.53	0.20
After Taste	8.20 ± 0.81	8.37 ± 0.67	8.07 ± 0.69	8.53 ± 0.90	8.00 ± 1.05	2.06	0.09
Mouthfeel	8.20 ± 0.71	8.27 ± 0.74	8.17 ± 0.75	8.47 ± 0.86	8.40 ± 0.86	0.81	0.52
Overall Acceptability	8.40 ± 0.86	8.50 ± 0.68	8.03 ± 0.76	8.53 ± 0.86	8.50 ± 0.90	1.94	0.1
Total	58.03 ± 4.90	58.37 ± 3.76	56.10 ± 4.40	59.63 ± 5.18	58.63 ± 4.67		

p value of unpaired 't' test (equal variance) of significantly different attributes of Seviyaan kheer made from different premixes.

	B vs J	B vs R	B vs K	B vs A	J vs R	J vs K	J vs A	R vs K	R vs A	K vs A
Colour and Appearance	0.77	0.05*	0.33	0.50	0.01*	0.43	0.64	0.002**	0.006**	0.73

* Significant difference at $p < 0.05$

** Significant difference at $p < 0.01$

*** Highly significant difference at $p < 0.001$

TABLE 4.17: COMPOSITE RATING SCORES FOR THALIPEETH MADE FROM DIFFERENT PREMIXES

Attributes	Bajra Premix (B)	Jowar Premix (J)	Ragi Premix (R)	Kodari Premix (K)	Amaranth Premix (A)	'F' value	P – value
Colour and Appearance	8.00 ± 0.74	8.30 ± 0.53	7.47 ± 0.73	8.80 ± 0.81	8.57 ± 0.82	15.05	0.00 ***
Aroma	8.20 ± 0.55	8.23 ± 0.73	7.60 ± 0.67	8.43 ± 0.63	8.70 ± 0.75	1.03	0.07
Texture	8.13 ± 0.63	8.10 ± 0.71	8.00 ± 0.98	8.50 ± 0.90	8.43 ± 0.73	2.26	0.06
Taste	8.17 ± 0.65	8.17 ± 0.83	8.30 ± 0.99	8.47 ± 0.86	8.70 ± 0.70	2.32	0.06
After Taste	8.27 ± 0.74	8.27 ± 0.91	8.00 ± 0.95	8.43 ± 0.90	8.47 ± 0.97	1.28	0.28
Mouthfeel	8.00 ± 0.64	8.20 ± 0.92	8.00 ± 1.05	8.43 ± 0.77	8.57 ± 0.86	2.64	0.04 *
Overall Acceptability	8.13 ± 0.63	8.33 ± 1.06	7.93 ± 0.91	8.67 ± 0.80	8.73 ± 0.83	4.77	0.00 ***
Total	56.90 ± 2.88	57.60 ± 4.77	55.30 ± 5.06	59.73 ± 3.83	60.17 ± 3.13		

p value of unpaired 't' test (equal variance) of significantly different attributes made from different premixes

	B vs J	B vs R	B vs K	B vs A	J vs R	J vs K	J vs A	R vs K	R vs A	K vs A
Colour and Appearance	0.08	0.01 *	0.00 ***	0.01 *	0.00 ***	0.006**	0.14	0.00 ***	0.00 ***	0.27
Mouthfeel	0.33	1	0.02 *	0.005 **	0.44	0.29	0.11	0.07	0.03 *	0.52
Overall Acceptability	0.38	0.32	0.006 **	0.002 **	0.12	0.17	0.11	0.00 ***	0.00 ***	0.75

* Significant difference at $p < 0.05$

** Significant difference at $p < 0.01$

*** Highly significant difference at $p < 0.001$

TABLE 4.18: COMPOSITE RATING SCORES FOR TIKKI MADE FROM DIFFERENT PREMIXES

Attributes	Bajra Premix (B)	Jowar Premix (J)	Ragi Premix (R)	Kodari Premix (K)	Amaranth Premix (A)	'F' value	p value
Colour and Appearance	8.03 ± 0.89	8.67 ± 0.66	8.13 ± 1.11	8.40 ± 0.80	8.60 ± 0.81	3.09	0.02*
Aroma	7.90 ± 0.80	8.50 ± 0.94	7.97 ± 1.16	8.27± 0.68	8.10 ± 0.88	2.13	0.08
Texture	8.17 ± 0.75	8.27 ± 1.01	8.53 ± 0.86	7.90 ± 0.87	8.20 ± 0.61	2.22	0.07
Taste	8.23 ± 0.77	8.17 ± 0.83	8.30 ± 0.65	7.60 ± 1.08	7.97 ± 1.13	2.84	0.03*
After Taste	7.77 ± 0.77	8.00 ± 0.74	7.90 ± 1.09	8.27 ± 0.81	8.30 ± 0.75	2.24	0.07*
Mouthfeel	8.43 ± 0.73	8.13 ± 0.68	8.10 ± 1.09	8.30 ± 0.90	8.13 ± 073	0.86	0.49
Overall Acceptability	8.37 ± 0.96	8.23 ± 0.94	8.07 ± 0.83	8.23 ± 0.72	8.20 ± 0.66	0.50	0.74
Total	56.90 ± 3.91	57.97 ± 3.16	57.0 ± 4.43	56.97 ± 3.66	57.50 ± 3.06		

p value of unpaired 't' test (equal variance) of significantly different attributes of Tikki made from different premixes

	B vs J	B vs R	B vs K	B vs A	J vs R	J vs K	J vs A	R vs K	R vs A	K vs A
Colour and Appearance	0.00***	0.68	0.09	0.003**	0.06	0.23	0.70	0.006**	0.09	0.37
Taste	0.73	0.72	0.01*	0.24	0.44	0.04*	0.36	0.00***	0.13	0.11
After taste	0.16	0.58	0.04*	0.03*	0.65	0.2	0.17	0.02*	0.11	0.57

* Significant difference at $p < 0.05$

** Significant difference at $p < 0.01$

*** Highly significant difference at $p < 0.001$

0.001) found between the taste of tikka prepared from Ragi and Kodari. The difference between tikki made from Bajra and Kodari, Jowar and Kodari was also found to be significant ($p < 0.05$, $p < 0.01$) for the same. Other attributes scores and the average total scores were alike for all tikki made from different multigrain premixes.

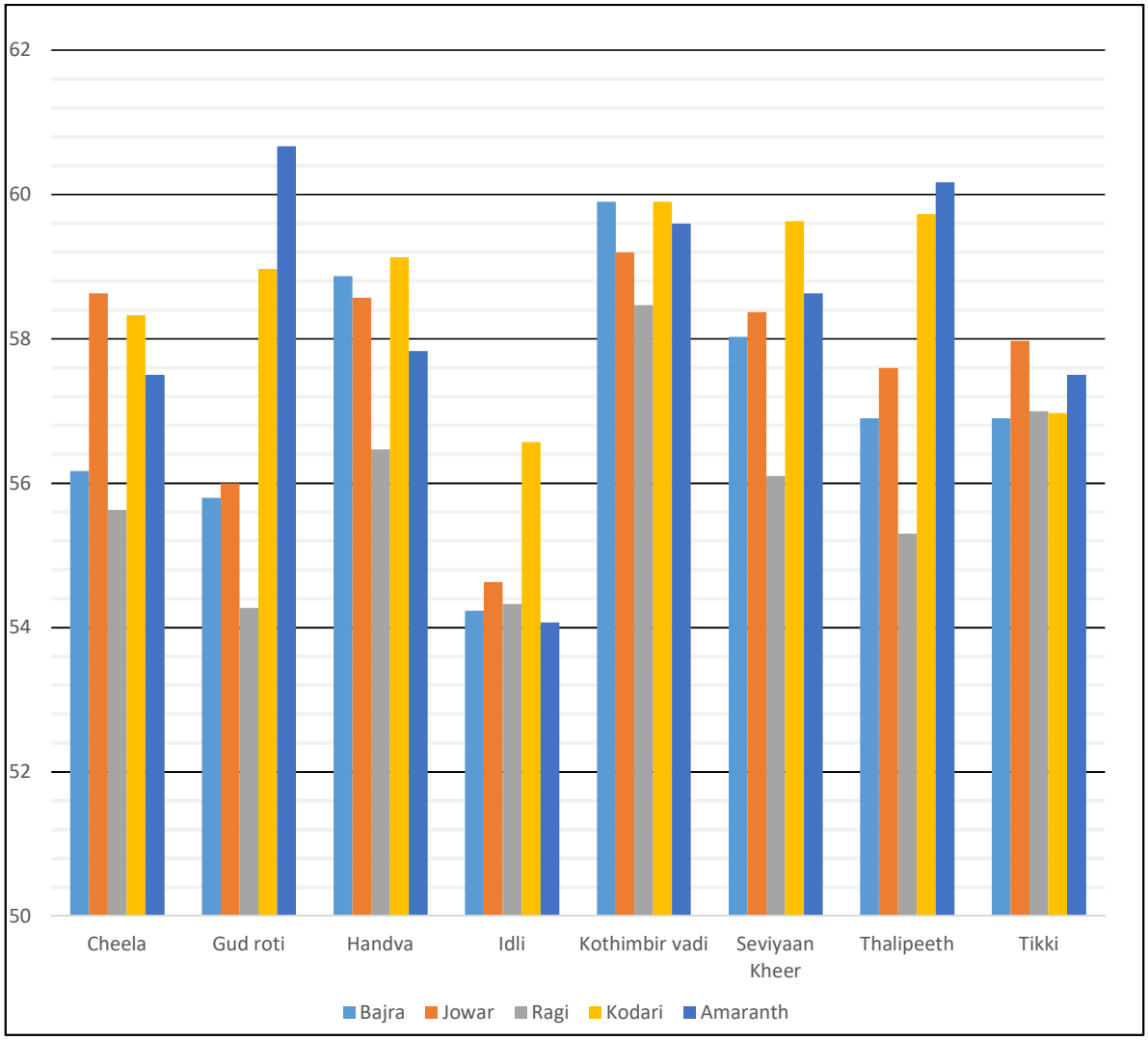
As seen in figure 4.1, for Cheela the premix version that had the highest total average score was Jowar, same was the case for Tikki. For Gud roti and Thalipeeth, the highest score was for thalipeeth made from Amaranth premix. Kodari premix incorporated Idli, Handva and Seviyaan Kheer was the most liked. For Kothimbir vadi, the one made from Bajra and Kodari premix had almost similar average total score. The recipe which had the highest total average score amongst all the recipes and their version was Amaranth premix incorporated Gud roti.

ii.Composite test score comparison of different recipes made using the same multigrain premixes.

1. Bajra premix recipes

Table 4.19 depicts that all the attributes of the recipes made from Bajra premix. For all the attributes the scores were found to be more than 7.5 which showed their higher acceptability by the panellists. The attributes that showed significant difference after ANOVA test were aroma, texture and aftertaste. With respect to colour and appearance, the differences between recipes Gud roti and Handva, Gud roti and Kothimbir vadi, Handva and Idli, Handva and Thalipeeth, Handva and Tikki, Seviyaan Kheer and Tikki were significant ($p < 0.05$, $p < 0.01$). As for texture, significant difference ($p < 0.05$, $p < 0.01$) was seen between Cheela and Idli, Gud roti and Idli, Handva and Idli, Idli and Kothimbir vadi, Idli and Seviyaan kheer, Idli and Thalipeeth, Idli and Tikki, Kothimbir vadi and Seviyaan kheer. Significant difference ($p < 0.05$, $p < 0.01$) was found in aftertaste attribute between the following recipes Cheela and Thalipeeth, Gud roti and Thalipeeth, Idli and Kothimbir vadi, Idli and Seviyaan kheer, Idli and Thalipeeth, Kothimbir vadi and Tikki, Seviyaan kheer and tikka, Thalipeeth and Tikki.

FIGURE 4.1: MEAN TOTAL SCORES OF COMPOSITE RATING FOR VARIATIONS OF ALL THE RECIPES MADE FROM DEVELOPED MULTIGRAIN PREMIXES



2. Jowar premix

The recipes made out of Jowar premix were similar with respect to aroma, mouthfeel and overall acceptability as for other attributes the scores (Table 4.20) were found to be significantly different. Colour and appearance score between Gud roti and Tikki, Idli and Kothimbir vadi, Idli and Tikki, Thalipeeth and Tikki were significantly different ($p < 0.05$, $p < 0.01$). As for texture, a highly significant difference ($p < 0.001$) was observed between Cheela and Idli while between Handva and Idli, Idli and Kothimbir vadi, Idli and Seviyaan Kheer, Idli and Tikki the differences were also significant ($p < 0.05$, $p < 0.01$). The scores for taste were significantly different ($p < 0.05$, $p < 0.01$) between Cheela and Gud roti, Cheela and Thalipeeth, Cheela and Tikki, Handva and Idli, Idli and Kothimbir vadi, Idli and Seviyaan Kheer, the difference between Cheela and Idli was highly significant ($p < 0.001$). Aftertaste score between Cheela and Gud roti, Cheela and Idli, Gud roti and Seviyaan Kheer, Handva and Idli, Idli and Kothimbir vadi, Idli and Seviyaan kheer, Idli and Thalipeeth were significantly different ($p < 0.05$, $p < 0.01$).

3. Ragi premix

After carrying out ANOVA test on the composite scores of the different recipes made from Ragi premix it was found that there were significant differences between the recipes based on the colour and appearance and aftertaste (Table 4.21).

When student's t test was carried out, there was significant difference ($p < 0.05$, $p < 0.01$) found between Gud roti and Kothimbir vadi, Gud roti and Tikki, Idli and Tikki, Kothimbir vadi and Thalipeeth, Thalipeeth and Tikki with respect to colour and appearance. As for aftertaste the significant differences ($p < 0.05$, $p < 0.01$) were observed between Cheela and Handva, Gud roti and Handva, Gud roti and Kothimbir vadi, Gud roti and Seviyaan kheer, Handva and Idli, Idli and Kothimbir vadi, Idli and Seviyaan Kheer.

TABLE 4.19: COMPOSITE RATING SCORES OF DIFFERENT RECIPES MADE FROM BAJRA PREMIX

	Cheela (C)	Gud roti (G)	Handva (H)	Idli (I)	Kothimbir vadi (K)	Seviyan Kheer (S)	Thalipeeth (T)	Tikki (Ti)	'F' test	p – value
Colour and appearance	7.80 ± 0.85	7.93 ± 1.05	8.30 ± 1.18	7.70 ± 0.95	8.37 ± 1.22	8.27 ± 0.98	8.00 ± 0.74	8.03 ± 0.89	1.78	0.09
Aroma	8.23 ± 0.86	8.00 ± 0.91	8.63 ± 1.00	7.77 ± 1.22	8.63 ± 1.30	8.43 ± 0.86	8.20 ± 0.55	7.90 ± 0.80	3.43 *	0.002
Texture	8.13 ± 0.68	8.07 ± 0.78	8.50 ± 1.01	7.50 ± 1.28	8.27 ± 1.31	8.20 ± 0.81	8.13 ± 0.63	8.17 ± 0.75	2.73 *	0.01
Taste	8.13 ± 1.01	7.90 ± 1.16	8.33 ± 1.35	7.80 ± 1.13	8.53 ± 1.25	8.33 ± 0.71	8.17 ± 0.65	8.23 ± 0.77	1.61	0.13
After taste	7.83 ± 0.87	7.77 ± 1.04	8.13 ± 1.14	7.70 ± 1.02	8.30 ± 1.15	8.20 ± 0.81	8.27 ± 0.74	7.77 ± 0.77	2.09 *	0.04
Mouthfeel	8.03 ± 0.96	7.97 ± 1.03	8.50 ± 1.07	7.83 ± 1.15	8.47 ± 1.43	8.20 ± 0.71	8.00 ± 0.64	8.43 ± 0.73	2.02	0.05
Overall acceptability	8.00 ± 0.79	8.17 ± 1.18	8.47 ± 1.17	7.93 ± 1.01	8.40 ± 1.48	8.40 ± 0.86	8.13 ± 0.63	8.37 ± 0.96	1.08	0.38
Total	56.17 ± 4.69	55.80 ± 4.90	58.87 ± 6.77	54.23 ± 6.82	58.97 ± 8.38	58.03 ± 4.90	56.90 ± 2.88	56.90 ± 3.91		

* Significant difference at $p < 0.05$

** Significant difference at $p < 0.01$

*** Highly significant difference at $p < 0.001$

p value of unpaired 't' test (equal variance) of significantly different attributes of different recipes made from the Bajra premix

	Aroma	Texture	After taste
C vs G	0.31	0.73	0.79
C vs H	0.10	0.10	0.26
C vs I	0.09	0.02*	0.59
C vs K	0.16	0.62	0.08
C vs S	0.37	0.73	0.10
C vs T	0.86	1.00	0.04*
C vs Ti	0.13	0.86	0.76
G vs H	0.01*	0.07	0.20
G vs I	0.41	0.04*	0.80
G vs K	0.03*	0.48	0.06
G vs S	0.06	0.52	0.08
G vs T	0.31	0.72	0.04*
G vs Ti	0.65	0.62	1.00
H vs I	0.004**	0.001**	0.13
H vs K	1.00	0.44	0.57
H vs S	0.41	0.21	0.79
H vs T	0.04*	0.10	0.59
H vs TI	0.003**	0.15	0.15
I vs K	0.01*	0.003**	0.04*
I vs S	0.02*	0.01*	0.04*
I vs T	0.08	0.02*	0.02*
I vs TI	0.62	0.002**	0.78
K vs S	0.48	0.81	0.70
K vs T	0.10	0.62	0.89
K vs TI	0.01*	0.72	0.04*
S vs T	0.22	0.72	0.74
S vs Ti	0.02*	0.87	0.04*
T vs Ti	0.10	0.85	0.01*

* Significant difference at $p < 0.05$

** Significant difference at $p < 0.01$

*** Highly significant difference at $p < 0.001$

TABLE 4.20: COMPOSITE RATING SCORES OF DIFFERENT RECIPES MADE FROM JOWAR PREMIX

	Cheela (C)	Gud roti (G)	Handva (H)	Idli (I)	Kothimbir vadi (K)	Seviyaan Kheer (S)	Thalipeeth (T)	Tikki (Ti)	'F' test	P – value
Colour and appearance	8.30 ± 0.84	8.00 ± 1.14	8.30 ± 1.24	7.93 ± 0.83	8.53 ± 0.97	8.33 ± 0.76	8.30 ± 0.53	8.67 ± 0.66	2.19*	0.04
Aroma	8.20 ± 1.03	7.93 ± 1.01	8.60 ± 1.22	7.90 ± 1.06	8.40 ± 1.40	8.20 ± 0.85	8.23 ± 0.73	8.52 ± 0.95	1.69	0.11
Texture	8.33 ± 0.92	8.03 ± 1.00	8.47 ± 1.07	7.60 ± 1.16	8.40 ± 1.13	8.30 ± 0.65	8.10 ± 0.71	8.27 ± 1.01	2.43*	0.02
Taste	8.63 ± 0.81	8.10 ± 0.96	8.43 ± 1.17	7.80 ± 0.89	8.60 ± 0.97	8.40 ± 0.72	8.17 ± 0.83	8.17 ± 0.83	2.89*	0.01
After taste	8.37 ± 0.72	7.87 ± 1.01	8.43 ± 1.14	7.80 ± 0.76	8.33 ± 0.99	8.37 ± 0.67	8.27 ± 0.91	8.00 ± 0.74	2.43*	0.02
Mouthfeel	8.37 ± 0.89	8.00 ± 0.95	8.17 ± 1.05	7.73 ± 0.91	8.40 ± 1.04	8.27 ± 0.74	8.20 ± 0.92	8.13 ± 0.68	1.68	0.11
Overall acceptability	8.43 ± 0.77	8.07 ± 1.08	8.17 ± 1.05	7.87 ± 0.82	8.53 ± 1.01	8.50 ± 0.68	8.33 ± 1.06	8.23 ± 0.94	1.80	0.09
Total	58.63 ± 4.66	56.00 ± 6.24	58.57 ± 6.86	54.63 ± 5.39	59.20 ± 6.62	58.37 ± 3.76	57.60 ± 4.77	57.97 ± 3.16		

* Significant difference at $p < 0.05$

** Significant difference at $p < 0.01$

*** Highly significant difference at $p < 0$.

p value of unpaired 't' test (equal variance) of significantly different attributes of different recipes made from the Jowar premix

	Colour and appearance	Texture	Taste	After taste
C vs G	0.25	0.23	0.02*	0.03*
C vs H	1.00	0.61	0.44	0.79
C vs I	0.09	0.00***	0.00***	0.004**
C vs K	0.32	0.80	0.89	0.88
C vs S	0.87	0.87	0.24	1.00
C vs T	1.00	0.28	0.03*	0.64
C vs Ti	0.06	0.79	0.03*	0.06
G vs H	0.33	0.11	0.23	0.05
G vs I	0.80	0.13	0.21	0.77
G vs K	0.06	0.19	0.05	0.08
G vs S	0.19	0.23	0.18	0.03*
G vs T	0.20	0.77	0.77	0.11
G vs Ti	0.01*	0.37	0.77	0.56
H vs I	0.18	0.004**	0.02*	0.01*
H vs K	0.42	0.82	0.55	0.72
H vs S	0.90	0.47	0.89	0.78
H vs T	1.00	0.12	0.31	0.53
H vs TI	0.16	0.46	0.31	0.09
I vs K	0.01*	0.01*	0.001**	0.02*
I vs S	0.06	0.006**	0.006**	0.003**
I vs T	0.05	0.05	0.10	0.04*
I vs TI	0.00***	0.02*	0.10	0.31
K vs S	0.38	0.68	0.37	0.88
K vs T	0.25	0.22	0.07	0.79
K vs TI	0.54	0.63	0.07	0.15
S vs T	0.84	0.26	0.23	0.63
S vs Ti	0.07	0.88	0.25	0.05
T vs Ti	0.02*	0.46	1.00	0.22

* Significant difference at $p < 0.05$

** Significant difference at $p < 0.01$

*** Highly significant difference at $p < 0.001$

4. Kodari Premix

Recipes prepared from Kodari premixes had significant differences in the scores for texture and taste (Table 4.22). The differences between Gud roti and Kothimbir vadi, Gud roti and Seviyaan Kheer, Gud roti and Thalipeeth, Handva and Tikki, Kothimbir vadi and Tikki, Seviyaan Kheer and Tikki, Thalipeeth and Tikki were significant ($p < 0.05$, $p < 0.01$) with respect to texture. For taste the significant differences ($p < 0.05$, $p < 0.01$) were seen between Cheela and Tikki, Gud roti and Idli, Handva and Tikki, Idli and Tikki, Seviyaan Kheer and Tikki, Thalipeeth and Tikki while the difference between Gud roti and Tikki, Kothimbir vadi and Tikki was highly significant ($p < 0.001$).

5. Amaranth premix

Except for colour and appearance all the other attributes of the recipes prepared from Amaranth premix had significant differences between them (Table 4.23). Significant differences ($p < 0.05$, $p < 0.01$) in aroma were seen between Cheela and Thalipeeth, Gud roti and Idli, Gud roti and Tikki, Handva and Thalipeeth, Idli and Kothimbir vadi, Idli and Thalipeeth, Thalipeeth and Tikki. As for texture, differences between Cheela and Idli, Gud roti and Idli, Gud roti and Tikki, Idli and Kothimbir vadi, Idli and Seviyaan Kheer, Idli and Thalipeeth were found to be significant ($p < 0.05$, $p < 0.01$). The differences between Gud roti and Idli, Idli and Kothimbir vadi, Idli and Thalipeeth, Gud roti and Tikkiwere found to highly significant ($p < 0.01$) for taste scores while between Thalipeeth and Tikki, Kothimbir vadi and Tikki, Idli and Seviyaan kheer, Gud roti and Handva, Cheela and Kothimbir vadi, Cheela and Idli, Cheela and Gud roti

TABLE 4.21: COMPOSITE RATING SCORES OF DIFFERENT RECIPES MADE FROM RAGI PREMIX

	Cheela (C)	Gud roti (G)	Handva (H)	Idli (I)	Kothimbir vadi (K)	Seviyaan Kheer (S)	Thalipeeth (T)	Tikki (Ti)	'F' test	p – value
Colour and appearance	7.83 ± 1.09	7.33 ± 1.15	7.83 ± 1.26	7.67 ± 1.06	8.20 ± 1.56	7.80 ± 0.81	7.47 ± 0.73	8.13 ± 1.11	2.10*	0.04
Aroma	8.23 ± 1.07	7.63 ± 1.19	8.07 ± 1.28	7.80 ± 1.06	8.30 ± 1.32	8.00 ± 0.91	7.60 ± 067	7.97 ± 1.16	1.64	0.12
Texture	7.97 ± 0.89	7.97 ± 0.93	7.80 ± 1.30	7.90 ± 0.80	8.33 ± 1.24	7.97 ± 0.85	8.00 ± 0.98	8.53 ± 0.86	1.82	0.08
Taste	8.00 ± 1.14	8.07 ± 0.91	8.03 ± 1.16	7.93 ± 0.78	8.40 ± 1.28	8.07 ± 0.69	8.30 ± 0.99	8.30 ± 0.65	0.92	0.49
After taste	7.80 ± 1.03	7.70 ± 0.75	8.43 ± 1.14	7.57 ± 0.90	8.33 ± 1.24	8.07 ± 0.69	8.00 ± 0.95	7.90 ± 1.09	2.74*	0.00
Mouthfeel	7.77 ± 1.22	7.80 ± 0.76	8.17 ± 1.09	7.63 ± 1.03	8.30 ± 1.47	8.17 ± 0.75	8.00 ± 1.05	8.10 ± 1.09	0.20	0.20
Overall acceptability	8.03 ± 1.13	7.77 ± 0.82	8.13 ± 1.20	7.83 ± 0.91	8.60 ± 1.07	8.03 ± 0.76	7.93 ± 0.91	8.07 ± 0.83	2.08	0.05
Total	55.63 ± 6.48	54.27 ± 5.48	56.47 ± 7.42	54.33 ± 5.41	58.47 ± 7.98	56.10 ± 4.40	55.30 ± 5.06	57.00 ± 4.43		

* Significant difference at $p < 0.05$

** Significant difference at $p < 0.01$

*** Highly significant difference at $p < 0.001$

p value of unpaired 't' test (equal variance) of significantly different attributes of different recipes made from the Ragi premix

	Colour and appearance	After taste
C vs G	0.09	0.67
C vs H	1.00	0.03*
C vs I	0.55	0.35
C vs K	0.30	0.08
C vs S	0.89	0.24
C vs T	0.13	0.44
C vs Ti	0.29	0.72
G vs H	0.11	0.005**
G vs I	0.25	0.53
G vs K	0.02*	0.02*
G vs S	0.07	0.05
G vs T	0.60	0.18
G vs Ti	0.01*	0.41
H vs I	0.58	0.002**
H vs K	0.32	0.75
H vs S	0.90	0.14
H vs T	0.17	0.11
H vs TI	0.33	0.07
I vs K	0.13	0.01*
I vs S	0.59	0.02*
I vs T	0.40	0.07
I vs TI	0.10	0.20
K vs S	0.22	0.31
K vs T	0.02*	0.25
K vs TI	0.85	0.16
S vs T	0.10	0.76
S vs Ti	0.19	0.48
T vs Ti	0.003**	0.71

* Significant difference at $p < 0.05$

** Significant difference at $p < 0.01$

*** Highly significant difference at $p < 0.001$

TABLE 4.22: COMPOSITE RATING SCORES OF DIFFERENT RECIPES MADE FROM KODARI PREMIX

	Cheela (C)	Gud roti (G)	Handva (H)	Idli (I)	Kothimbir vadi (K)	Seviyaan Kheer (S)	Thalipeeth (T)	Tikki (Ti)	'F' test	p – value
Colour and appearance	8.50 ± 0.86	8.47 ± 0.86	8.33 ± 1.27	8.10 ± 0.80	8.73 ± 0.74	8.50 ± 0.86	8.80 ± 0.81	8.40 ± 0.80	1.83	0.08
Aroma	8.27 ± 0.91	8.53 ± 0.68	8.30 ± 1.18	7.93 ± 0.94	8.60 ± 1.22	8.57 ± 0.94	8.43 ± 0.94	8.43 ± 0.63	8.27 ± 0.68	0.11
Texture	8.30 ± 0.99	8.00 ± 0.74	8.47 ± 1.11	8.20 ± 0.66	8.47 ± 0.86	8.47 ± 0.86	8.50 ± 0.90	7.90 ± 0.87	2.09*	0.04
Taste	8.30 ± 1.02	8.63 ± 0.81	8.50 ± 1.20	8.17 ± 0.79	8.53 ± 0.90	8.57 ± 0.97	8.47 ± 0.86	7.60 ± 1.08	3.65*	0.00
After taste	8.23 ± 0.97	8.40 ± 0.72	8.40 ± 1.25	8.03 ± 0.81	8.53 ± 0.97	8.53 ± 0.90	8.43 ± 0.90	8.27 ± 0.81	0.99	0.42
Mouthfeel	8.33 ± 0.92	8.43 ± 0.63	8.57 ± 0.94	7.97 ± 0.85	8.43 ± 1.01	8.47 ± 0.86	8.43 ± 0.77	8.30 ± 0.90	1.30	0.25
Overall acceptability	8.40 ± 0.89	8.50 ± 0.86	8.57 ± 1.07	8.17 ± 0.70	8.60 ± 0.81	8.53 ± 0.86	8.67 ± 0.80	8.23 ± 0.72	1.32	0.24
Total	58.33 ± 5.28	58.97 ± 3.46	59.13 ± 7.26	56.57 ± 4.07	59.90 ± 5.11	59.63 ± 5.18	59.73 ± 3.83	56.97 ± 3.66		

* Significant difference at $p < 0.05$

** Significant difference at $p < 0.01$

*** Highly significant difference at $p < 0.001$

p value of unpaired 't' test (equal variance) of significantly different attributes of different recipes made from the Kodari premix

	Texture	Taste
C vs G	0.19	0.17
C vs H	0.54	0.49
C vs I	0.65	0.57
C vs K	0.49	0.35
C vs S	0.49	0.30
C vs T	0.42	0.50
C vs Ti	0.10	0.01*
G vs H	0.06	0.61
G vs I	0.28	0.03*
G vs K	0.03*	0.65
G vs S	0.03*	0.77
G vs T	0.02*	0.44
G vs Ti	0.64	0.00***
H vs I	0.26	0.21
H vs K	1.00	0.90
H vs S	1.00	0.81
H vs T	0.90	0.90
H vs TI	0.03*	0.004**
I vs K	0.18	0.10
I vs S	0.18	0.09
I vs T	0.15	0.70
I vs TI	0.14	0.03*
K vs S	1.00	0.89
K vs T	0.88	0.77
K vs TI	0.01*	0.00***
S vs T	0.88	0.67
S vs Ti	0.01**	0.001**
T vs Ti	0.01*	0.001**

* Significant difference at $p < 0.05$

** Significant difference at $p < 0.01$

*** Highly significant difference at $p < 0.001$

TABLE 4.23: COMPOSITE RATING SCORES OF DIFFERENT RECIPES MADE FROM AMARANTH PREMIX

	Cheela (C)	Gud roti (G)	Handva (H)	Idli (I)	Kothimbir vadi (K)	Seviyaan Kheer (S)	Thalipeeth (T)	Tikki (Ti)	'F' test	p - value
Colour and appearance	8.30 ± 0.79	8.73 ± 0.98	8.60 ± 1.25	8.23 ± 0.97	8.77 ± 0.86	8.43 ± 0.90	8.57 ± 0.82	8.60 ± 0.81	1.27	0.26
Aroma	8.20 ± 0.85	8.60 ± 0.77	8.20 ± 1.27	7.97 ± 1.16	8.57 ± 1.10	8.40 ± 0.77	8.70 ± 0.75	8.10 ± 0.88	2.25*	0.03
Texture	8.33 ± 0.76	8.60 ± 0.77	8.30 ± 1.39	7.83 ± 1.26	8.60 ± 0.97	8.50 ± 0.86	8.43 ± 0.73	8.20 ± 0.61	2.10*	0.04
Taste	8.23 ± 1.10	8.90 ± 0.80	8.13 ± 1.59	7.50 ± 1.11	8.73 ± 0.83	8.40 ± 0.89	8.70 ± 0.70	7.97 ± 1.13	5.79*	0.00
After taste	8.00 ± 0.91	8.00 ± 1.08	8.10 ± 1.81	7.40 ± 1.07	8.00 ± 1.20	8.00 ± 1.05	8.47 ± 0.97	8.30 ± 0.75	2.19*	0.03
Mouthfeel	8.17 ± 0.75	8.80 ± 0.92	8.23 ± 1.43	7.50 ± 0.97	8.47 ± 1.22	8.40 ± 0.86	8.57 ± 0.86	8.13 ± 0.73	4.54*	0.00
Overall acceptability	8.27 ± 0.94	9.03 ± 0.89	8.27 ± 1.53	7.63 ± 1.13	8.47 ± 1.22	8.50 ± 0.90	8.73 ± 0.83	8.20 ± 0.66	4.67*	0.00
Total	57.50 ± 4.45	60.67 ± 3.38	57.83 ± 9.30	54.07 ± 6.79	59.60 ± 6.08	58.63 ± 4.67	60.17 ± 3.12	57.50 ± 3.06		

* Significant difference at $p < 0.05$

** Significant difference at $p < 0.01$

*** Highly significant difference at $p < 0.001$

p value of unpaired 't' test (equal variance) of significantly different attributes of different recipes made from the Amaranth premix

	Aroma	Texture	Taste	After taste	Mouthfeel	Overall acceptability
C vs G	0.06	0.18	0.01*	1.00	0.005**	0.002**
C vs H	1.00	0.91	0.78	0.79	0.82	1.00
C vs I	0.38	0.0	0.01*	0.02*	0.004**	0.02*
C vs K	0.15	0.24	0.05	1.00	0.26	0.48
C vs S	0.34	0.43	0.52	1.00	0.26	0.33
C vs T	0.02*	0.60	0.06	0.06	0.06	0.05
C vs Ti	0.66	0.46	0.36	0.17	0.86	0.75
G vs H	0.15	0.31	0.02*	0.80	0.07	0.02*
G vs I	0.02*	0.01*	0.00***	0.04*	0.00***	0.00***
G vs K	0.89	1.00	0.43	1.00	0.24	0.04*
G vs S	0.32	0.64	0.03*	1.00	0.09	0.02*
G vs T	0.61	0.39	0.31	0.08	0.32	0.18
G vs Ti	0.02*	0.03*	0.000***	0.22	0.003**	0.00**
H vs I	0.46	0.16	0.08	0.07	0.02*	0.07
H vs K	0.24	0.34	0.07	0.80	0.50	0.58
H vs S	0.46	0.51	0.43	0.79	0.59	0.47
H vs T	0.07	0.64	0.08	0.33	0.28	0.15
H vs TI	0.72	0.72	0.64	0.58	0.73	0.83
I vs K	0.04*	0.01*	0.00***	0.05	0.001**	0.01*
I vs S	0.09	0.02*	0.001**	0.03*	0.00***	0.002**
I vs T	0.005**	0.03*	0.00***	0.00***	0.00***	0.00***
I vs TI	0.62	0.16	0.11	0.00***	0.006**	0.02*
K vs S	0.50	0.67	0.14	1.00	0.81	0.90
K vs T	0.59	0.45	0.87	0.10	0.72	0.33
K vs TI	0.08	0.06	0.004**	0.25	0.21	0.30
S vs T	0.13	0.75	0.15	0.08	0.45	0.30
S vs Ti	0.17	0.12	0.10	0.21	0.20	0.15
T vs Ti	0.01*	0.18	0.004**	0.46	0.04	0.01*

* Significant difference at $p < 0.05$

** Significant difference at $p < 0.01$

*** Highly significant difference at $p < 0.001$

the differences were also significant ($p < 0.05$, $p < 0.01$). Differences in aftertaste score between Cheela and Idli, Gud roti and Idli, Handva and Idli, Idli and Seviyaan Kheer were significant ($p < 0.05$, $p < 0.01$) while between Idli and Thalipeeth, Idli and Tikki the differences were highly significant ($p < 0.001$). Differences between Gud roti and Idli, Idli and Thalipeeth were highly significant ($p < 0.001$) for mouthfeel and overall acceptability both. Difference for mouthfeel between Cheela and Gud roti, Cheela and Idli, Gud roti and Tikki, Handva and Idli, Idli and Kothimbir vadi, Idli and Seviyaan Kheer, Idli and Tikki, Thalipeeth and Tikki were significant ($p < 0.05$, $p < 0.01$) too and for overall acceptability the significant differences ($p < 0.05$, $p < 0.01$) were seen between Thalipeeth and Tikki, Idli and Tikki, Idli and Seviyaan Kheer, Idli and Kothimbir vadi, Handva and Idli, Gud roti and Seviyaan Kheer, Gud roti and Handva, Cheela and Idli, Cheela and Gud roti.

iii.7-point Hedonic test score comparison of individual recipes made using different multigrain premixes.

The hedonic scores of the recipes developed from different premixes had average scores above 5 which indicated that they were well accepted by the panellists (Table 4.24). On applying the ANOVA test, difference was observed in gud roti and thalipeeth recipes made from the different premixes, further the student's t test was applied to analyse difference in between the recipes.

The difference was significant ($p < 0.05$, $p < 0.01$) between Bajra and Kodari, Bajra and Amaranth, Jowar and Amaranth for Gud roti while the difference was highly significant ($p < 0.01$) for Ragi and Kodari and Ragi and Amaranth. As for Thalipeeth, the difference between Bajra and Kodari, Bajra and Amaranth, Jowar and Amaranth, Ragi and Kodari, Ragi and Amaranth group were significant ($p < 0.05$, $p < 0.01$).

iv.7-point Hedonic test score comparison of different recipes made using the same multigrain premixes.

Hedonic score of recipes made from the same premixes were compared to each other (Table 4.25) significant difference was found between the recipes made from Bajra and Amaranth premix. For all the recipes compared, the hedonic scores are above 5 indicating their high acceptability by the panellist

With respect to Bajra premix, there was significant difference ($p < 0.05$, $p < 0.01$) was observed between Cheela and Seviyaan kheer, Cheela and Tikki, Gud roti and Seviyaan kheer, Gud roti

and Tikki, Handva and Idli, Idli and Seviyaan Kheer, Idli and Thalipeeth. While a highly significant ($p < 0.001$) was observed between Idli and Tikki.

For Amaranth premix, significant difference ($p < 0.05$, $p < 0.01$) was observed between Gud roti and Handva, Gud roti and Idli, Idli and Seviyaan kheer, Idli and Thalipeeth, Idli and Tikki.

v. Serving size sufficiency of the recipes made from the developed multigrain premixes.

The semi-trained panellists of the sensory evaluation were also asked about the serving size sufficiency of the recipes with respect to pre-schoolers.

Figure 4.2 and 4.3 illustrates the results of the recipes rated for their sufficiency with respect to serving size for pre-schoolers. 80% panellists said that the serving size of Cheela and Gud roti were sufficient for pre-schoolers while others thought that the serving size was more than sufficient. Serving size of Handva was said to be more than sufficient by 83% panellists, while the same percentage of people said that serving size of Idli was sufficient. 97% and 93% panellists said that the serving size of Thalipeeth and Tikki are sufficient while 87% said that serving size of Kothimbir vadi and Seviyaan kheer are sufficient for pre-schoolers

TABLE 4.24: HEDONIC SCORES OF RECIPES MADE FROM DIFFERENT DEVELOPED MULTIGRAIN PREMIXES

	Mean and Standard Deviation					'F' test	p – value
	Bajra (B)	Jowar (J)	Ragi (R)	Kodari (K)	Amaranth (A)		
Cheela	5.90 ± 0.84	6.20 ± 0.75	5.70 ± 0.92	6.17 ± 0.99	6.13 ± 0.82	2.27	0.06
Gud roti	5.83 ± 1.02	6.07 ± 0.83	5.77 ± 0.68	6.40 ± 0.62	6.53 ± 0.73	5.54 *	0.00
Handva	6.27 ± 0.91	6.07 ± 0.98	6.03 ± 0.96	6.20 ± 0.89	5.87 ± 1.31	0.70	0.59
Idli	5.67 ± 0.84	5.73 ± 0.83	5.77 ± 0.90	5.97 ± 0.72	5.73 ± 0.98	0.53	0.71
Kothimbir vadi	6.03 ± 1.25	6.30 ± 0.79	6.13 ± 1.07	6.30 ± 0.70	6.20 ± 0.81	0.44	0.78
Seviyaan Kheer	6.30 ± 0.60	6.23 ± 0.63	6.07 ± 0.58	6.40 ± 0.62	6.37 ± 0.76	1.27	0.11
Thalipeeth	6.10 ± 0.61	6.13 ± 0.68	6.00 ± 0.83	6.43 ± 0.63	6.47 ± 0.57	2.95*	0.02
Tikki	6.43 ± 0.68	6.23 ± 0.77	6.23 ± 0.82	6.13 ± 0.97	6.33 ± 0.84	0.57	0.68

p value of unpaired 't' test (equal variance) of hedonic scores of recipes made from different premixes

	B vs J	B vs R	B vs K	B vs A	J vs R	J vs K	J vs A	R vs K	R vs A	K vs A
Gud roti	0.3	0.76	0.01*	0.003**	0.13	0.08	0.02*	0.00***	0.00**	0.45
Thalipeeth	0.8	0.60	0.04*	0.02*	0.50	0.08	0.04*	0.03*	0.01*	0.83

* Significant difference at $p < 0.05$

** Significant difference at $p < 0.01$

*** Highly significant difference at $p < 0.001$

TABLE 4.25: HEDONIC SCORES OF DIFFERENT RECIPES MADE FROM THE SAME DEVELOPED MULTIGRAIN PREMIXES

	Mean and Standard Deviation								'F' test	p – value
	Cheela (C)	Gud roti (G)	Handva (H)	Idli (I)	Kothimbir vadi (K)	Seviyaan kheer (S)	Thalipeeth (T)	Tikki (Ti)		
Bajra premix	5.90 ± 0.84	5.83 ± 1.02	6.27 ± 0.91	5.67 ± 0.84	6.03 ± 1.25	6.30 ± 0.60	6.10 ± 0.61	6.43 ± 0.68	2.69	0.10*
Jowar premix	6.30 ± 0.75	6.07 ± 0.83	6.07 ± 0.98	5.73 ± 0.83	6.30 ± 0.79	6.23 ± 0.63	6.13 ± 0.63	6.23 ± 0.77	1.68	0.11
Ragi premix	5.70 ± 0.92	5.77 ± 0.68	6.03 ± 0.96	5.77 ± 0.90	6.13 ± 1.07	6.07 ± 0.58	6.00 ± 0.83	6.23 ± 0.82	1.54	0.15
Kodari premix	6.17 ± 0.99	6.40 ± 0.62	6.20 ± 0.89	5.97 ± 0.72	6.30 ± 0.70	6.40 ± 0.62	6.43 ± 0.63	6.13 ± 0.97	1.30	0.25
Amaranth premix	6.13 ± 0.82	6.53 ± 0.73	5.87 ± 1.31	5.73 ± 0.98	6.20 ± 0.81	6.37 ± 0.76	6.47 ± 0.57	6.33 ± 0.84	3.13	0.003**

* Significant difference at $p < 0.05$

** Significant difference at $p < 0.01$

*** Highly significant difference at $p < 0.001$

p value of unpaired ‘t’ test (equal variance) of significantly different hedonic scores of recipes made from the same premixes

	Bajra premix	Amaranth premix
C vs G	0.78	0.05
C vs H	0.11	0.35
C vs I	0.29	0.09
C vs K	0.63	0.75
C vs S	0.04*	0.26
C vs T	0.30	0.07
C vs Ti	0.01*	0.36
G vs H	0.09	0.02*
G vs I	0.49	0.001**
G vs K	0.50	0.10
G vs S	0.03*	0.39
G vs T	0.22	0.70
G vs Ti	0.01*	0.33
H vs I	0.01*	0.66
H vs K	0.41	0.24
H vs S	0.87	0.08
H vs T	0.41	0.02
H vs TI	0.42	0.11
I vs K	0.19	0.05
I vs S	0.001**	0.01*
I vs T	0.03*	0.001**
I vs TI	0.00***	0.01*
K vs S	0.29	0.41
K vs T	0.79	0.14
K vs TI	0.13	0.53
S vs T	0.20	0.57
S vs Ti	0.42	0.87
T vs Ti	0.05	0.48

* Significant difference at $p < 0.05$

** Significant difference at $p < 0.01$

*** Highly significant difference at $p < 0.001$

FIGURE 4.2: SERVING SIZE SUFFICIENCY OF CHEELA

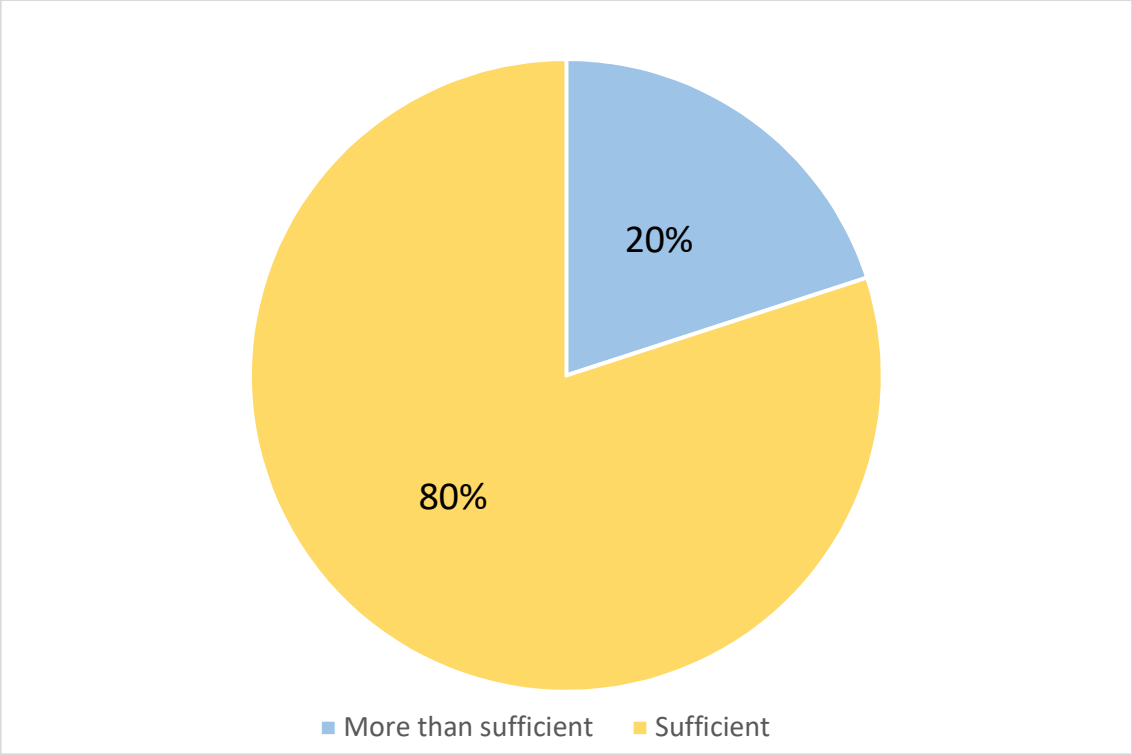


FIGURE 4.3: SERVING SIZE SUFFICIENCY OF GUD ROTI

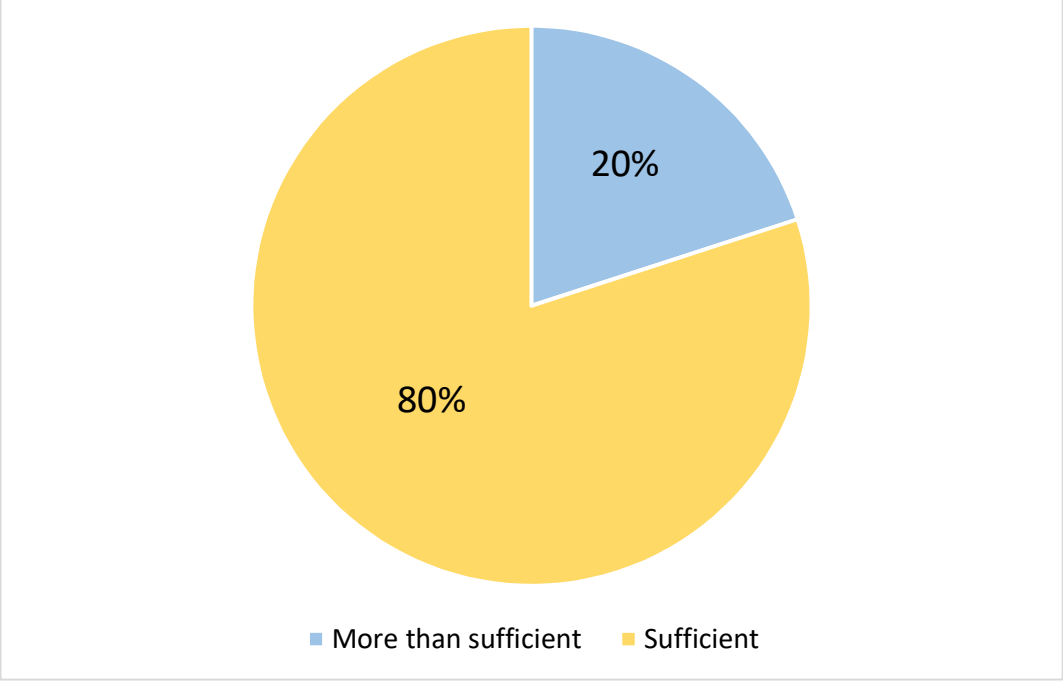


FIGURE 4.4: SERVING SIZE SUFFICIENCY OF HANDVA

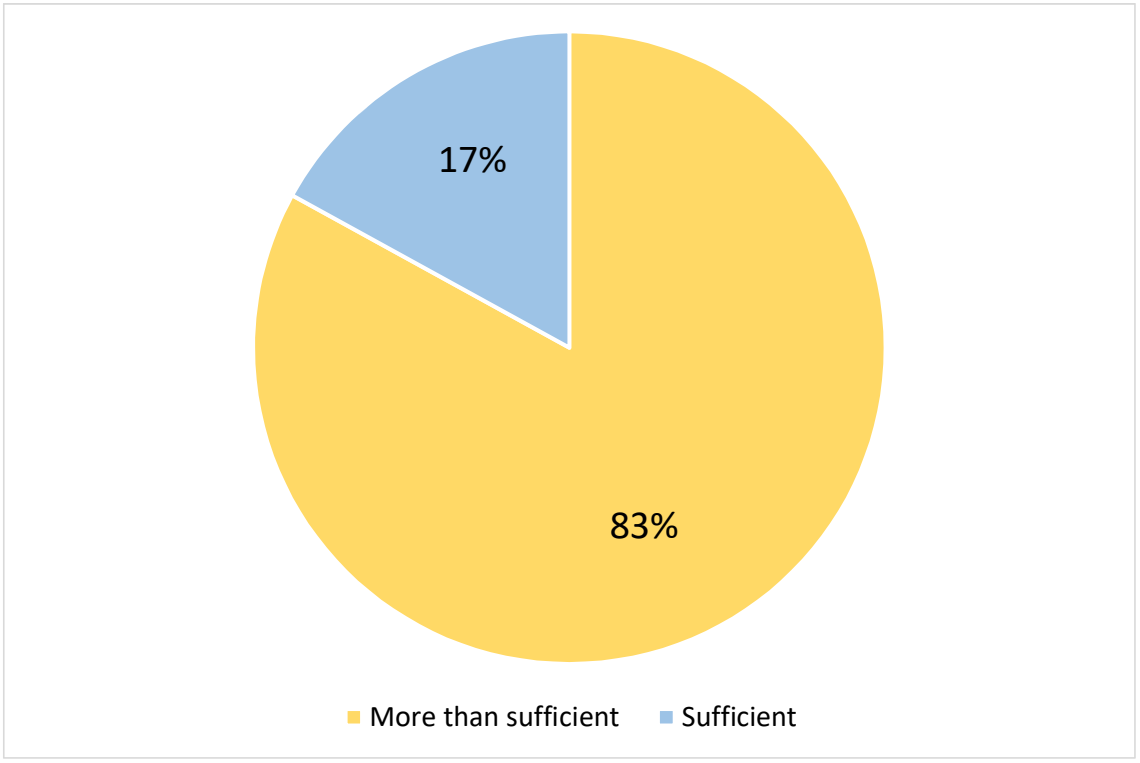


FIGURE 4.5: SERVING SIZE SUFFICIENCY OF IDLI

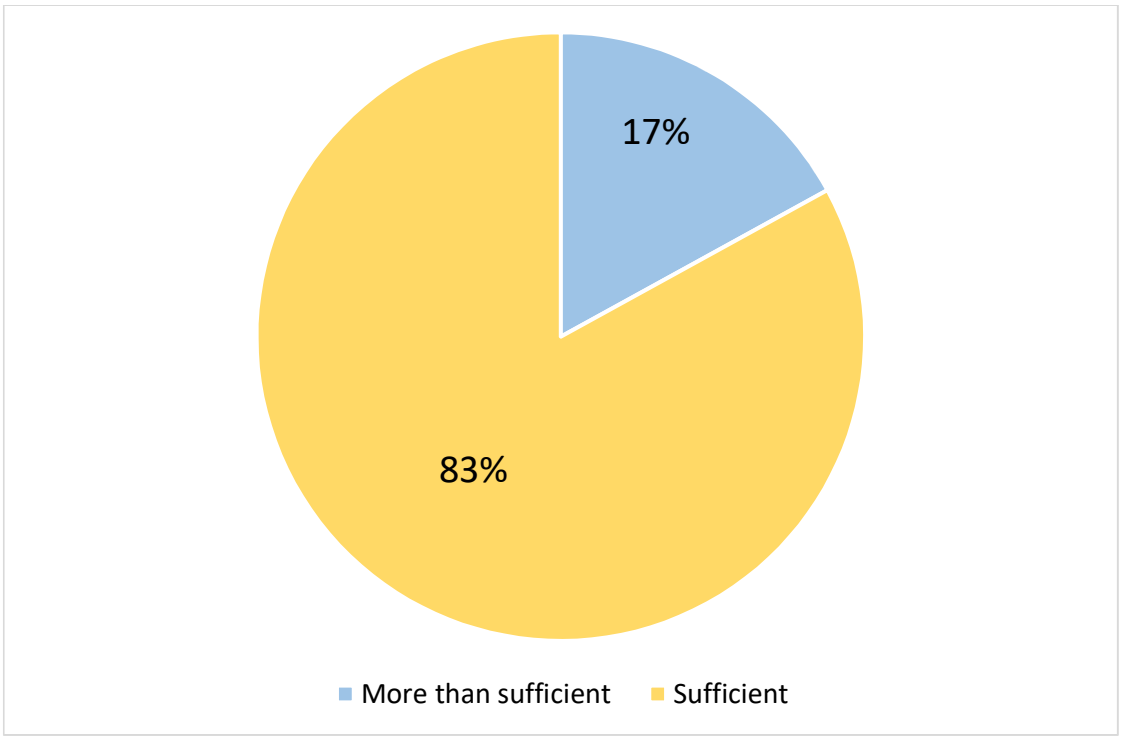


FIGURE 4.6: SERVING SIZE SUFFICIENCY OF KOTHIMBIR VADI

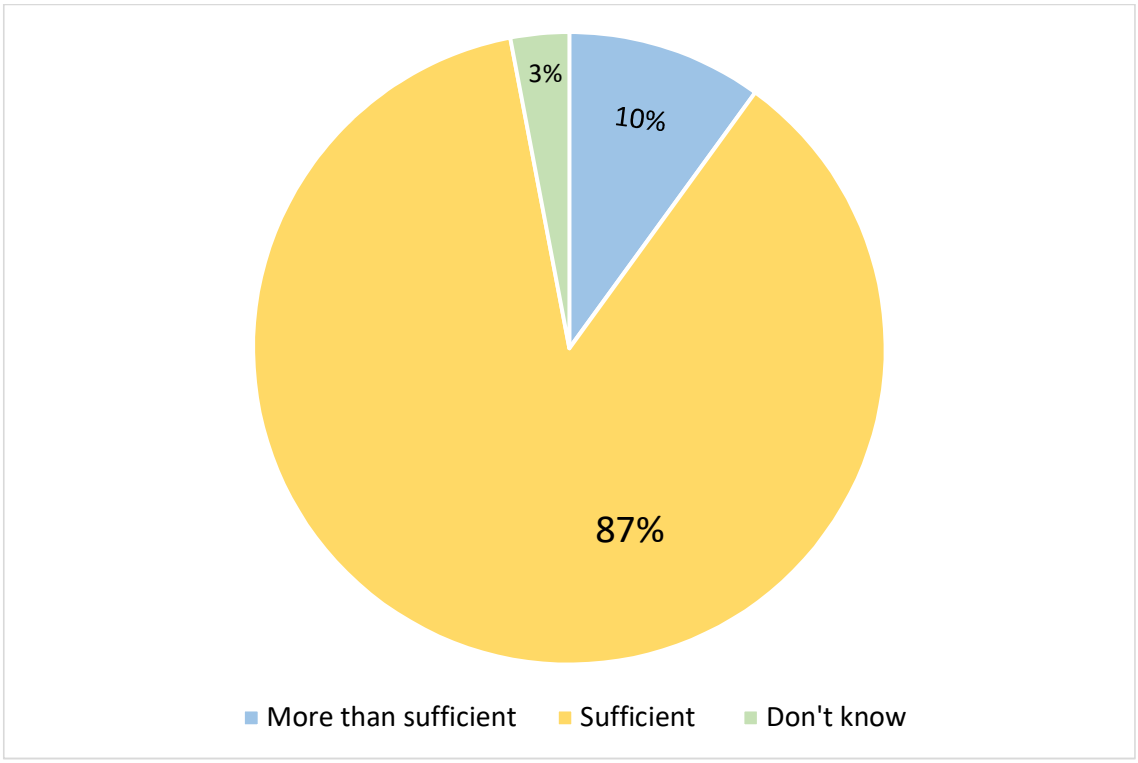


FIGURE 4.7: SERVING SIZE SUFFICIENCY OF SEVIYAAN KHEER

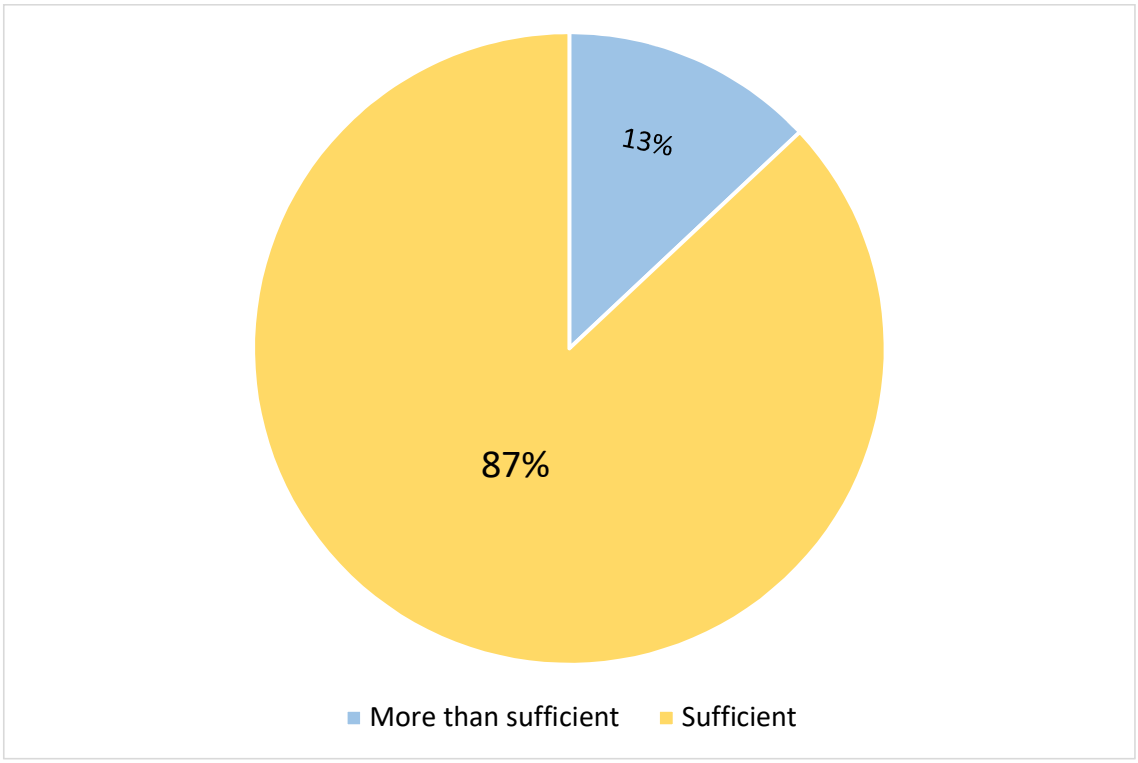


FIGURE 4.8: SERVING SIZE SUFFICIENCY OF THALIPEETH

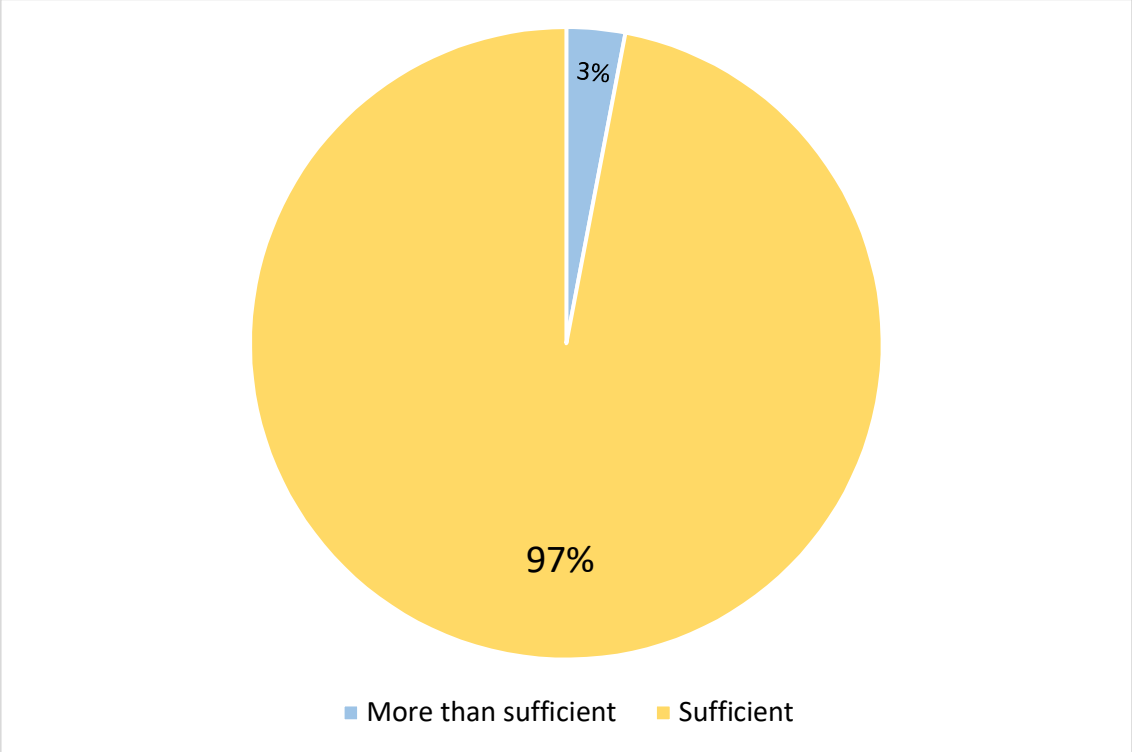
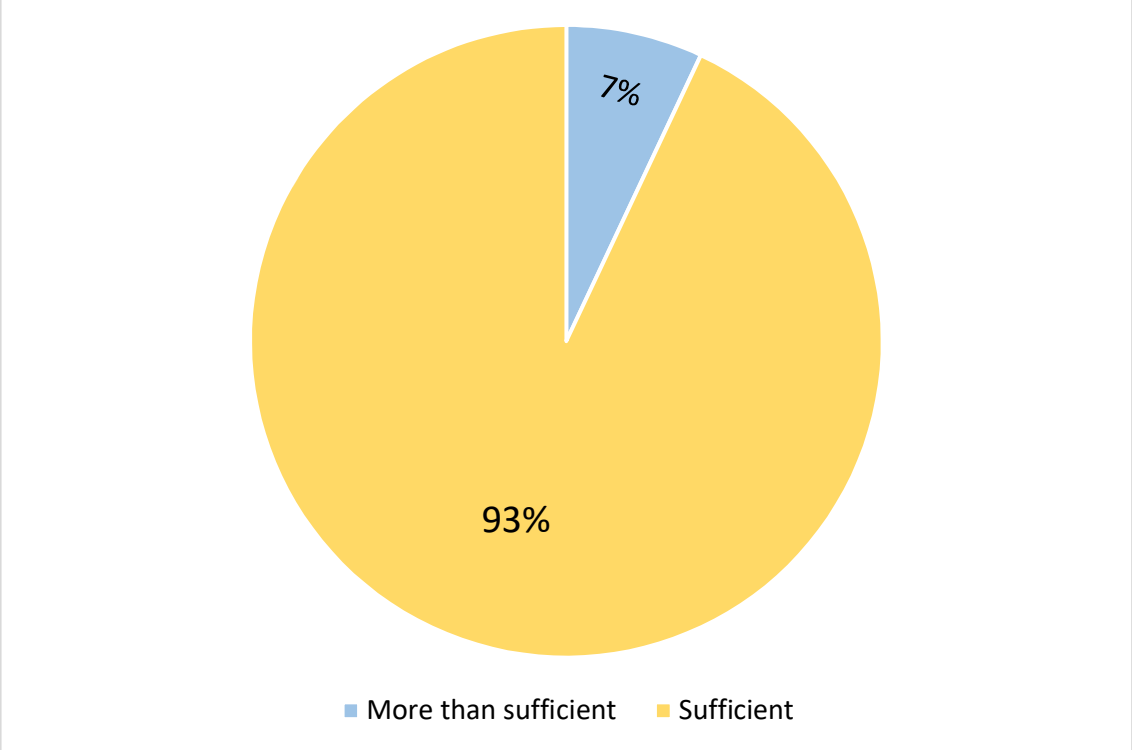


FIGURE 4.9: SERVING SIZE SUFFICIENCY OF TIKKI



Discussion

Children belonging in the pre-school age groups (3-5 years) are in a period of rapid physical and cognitive growth and development. This is the crucial moment in a child's life as the nutritional care provided in this timeline is more likely to set course of the child's health for a lifetime. One of the way's to ensure that a pre-schooler child's diet is providing him/her adequate nutrition is to adopt dietary diversity as a thumb of rule. Dietary diversity merely is to include foods from all the food groups in the diet in appropriate amounts and consistently, as it ensures optimal supply of required energy and nutrients – thus, preventing incidences of undernutrition and micronutrient deficiencies which are more often seen in children belonging to under 5-year age group.

National level health programmes in the country focuses heavily on pregnant women, lactating mothers and children under 2 years of age. Children above 3 years of age are a vulnerable group because of lack of policies attending to their needs, fuzzy eating behaviour and rapid changes in social (attending school) and family (arrival of a new sibling) environment. One of the ways to introduce dietary diversity with ease in a pre-schooler's diet is through premixes. Premixes are products that are manufactured using a lot of ingredients and can be incorporated in a variety of recipes. Commercially available premixes lack either diversity in the ingredients used, or lack the flexibility to be incorporated in a variety of recipes especially the ones expected by Indian pre-schoolers.

In this study, five multigrain premixes were developed which had wheat (cereal) and soybean (legume) as common ingredients and millets – Bajra, Jowar, Ragi, Kodari and Amaranth as the variable ingredients. These five developed premixes were further incorporated into eight recipes – Cheela, Gud roti, Handva, Idli, Kothimbir vadi, Seviyaan kheer, Thalipeeth and Tikki. Other than the cereal – millet – legume premix that was developed, while making the recipes the incorporation of fruits, vegetables, milk and milk products, nuts and oilseeds etc were also done wherever feasible so as to increase the dietary diversity of the recipes. The recipes and their attributes were evaluated for their sensory acceptability by 30 panellists, composite rating scale and 7-point hedonic test were done for the evaluation.

In this study, except for Gud roti no other recipe had significant differences in more than 3 sensory attributes in the composite rating test. In fact, Handva, Idli and Thalipeeth had no significant differences in their sensory attributes between any of its variations.

The results are in line with a study done by Tekele et all in 2015, evaluated acceptability of chickpea based ready to eat products was evaluated by mothers wherein the products which had combination of ingredients like chickpea + soybean, chickpea + maize and chickpea + soybean + maize had statistically equal overall acceptability.

With respect to colour and appearance of the recipes, differences were highly significant when other premixes variations were with Bajra or Ragi premix. The reason could be natural dark colouration of these millets comparatively. As other attributes, the significant differences between the premix variations didn't follow any trend.

This results of this study are in line with study conducted by Itagi et al (2013) where sensory evaluation of shelf stable halwa mixes showed that ragi flour inherited its dark brown colour in both sweet and savoury halwa which wasn't the case for the halwas made from wheat and sorghum mixes.

Gud roti was the only recipe which had significant difference in each of the sensory attributes in the composite rating test. The reason could be due to the peculiar sensory attributes like colour and taste of flours like Bajra, Jowar and Ragi being prominent in the recipe while Kodari and Amaranth flours don't have very strong properties which can be easily masked even without using spices or different flavours which was the case in this recipe

Similar results have been found in a study conducted by Guddad and Bharti, they formulated and evaluated a cereal based health mix which concluded that thepla made from the mix had a higher overall acceptability than the sweet preparation which was in the form of a laddo.

The higher ranking of Gud roti made from Amaranth premix in their composite rating test could be due to the fact that Amaranth flour is usually used to prepare sweet products like laddo and halwa, which made gud roti made from it more accepted as it is a familiar product. Also, the premix was roasted before making the recipe which must have led to a process called dextrinization which aids in improving flavour and texture.

Kothimbir vadi scores for composite rating test were statistically similar to each other and also above average which could be because of the incorporation of coriander leaves and various spices which could have helped in enhancing the flavours of the recipe. Two cooking methods were used to prepare this recipe – steaming and shallow frying which must have helped in enhancing the sensory attributes and acceptability.

When the composite rating test scores of the recipes made from the same premixes were compared to each other, there were significant differences in between the recipes of all the five premixes, the differences were mainly seen in colour and appearance, texture, after taste and overall acceptability. The differences must be because of the recipes belonging to different categories like sweet and savoury, prepared using different cooking methods and influence of other ingredients like vegetables, spices, milk and milk products, etc. which were used in different proportions in different recipes. For Amaranth premix, significant differences were seen in all of the attributes except for colour and appearance.

As depicted in the figures 4.10. i – 4.10.viii, Ragi premix was the least scoring premix in all of the eight recipes for composite rating test. The reason must be the inheritance of the dark colouration of Ragi flour from the premix. Also texture of products made from the flour tends to be dry, as ragi has low water absorbing capacity as seen in a study conducted by Ramashia et al that elaborated on physical and functional properties of ragi. The radar graph for all the recipes ware dispersed except for gud roti, indication the variations in the attributes was high for the higher for all the recipes as compared to that for gud roti

Figures 4.11.i – 4.11.v depicts that Idli was the least accepted recipe made from the five different multigrain premixes as per composite rating test. Idlis made from the multigrain premixes failed to achieve the desirable fermented flavour and texture as it turned out to have a little sticky texture and chewy mouthfeel. The radar graphs of the developed premixes and the recipes made from them are tightly knot to each other indicating not much difference in the attributes of the different recipes made from the same premix.

As for hedonic test, all the recipes made from the same premixes had similar score which was between 5-6, indicating that all the recipes were well accepted by the panellists. Similar result and inference was seen for the hedonic scores of individual recipes made from different multigrain premixes.

The serving size of all the recipes except for Handva was found to be sufficient for pre-school children by majority of the panellists. Serving size of Handva was said to be more than sufficient for a pre-schooler as the product was dense and thick.

FIGURE 4.10.i: COMPOSITE SCORES OF CHEELA VARIATIONS

FIGURE 4.10.ii: COMPOSITE SCORES OF GUD ROTI VARIATIONS

FIGURE 4.10.iii: COMPOSITE SCORES OF HANDVA VARIATIONS

FIGURE 4.10.iv: COMPOSITE SCORES OF IDLI VARIATIONS

FIGURE 4.10.v: COMPOSITE SCORES OF KOTHIMBIR VADI VARIATIONS

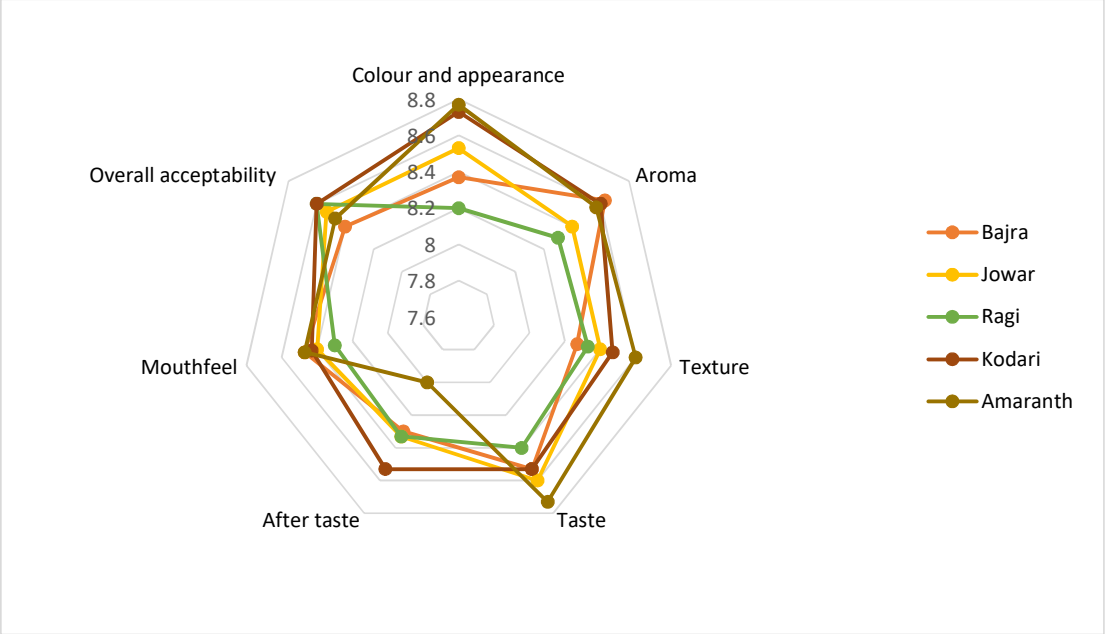


FIGURE 4.10.vi: COMPOSITE SCORES OF SEVIYAAN KHEER VARIATIONS

FIGURE 4.10.vii: COMPOSITE SCORES OF THALIPEETH VARIATIONS

FIGURE 4.10.viii: COMPOSITE SCORES OF TIKKI VARIATIONS

FIGURE 4.11.i: COMPOSITE SCORES OF RECIPES MADE FROM BAJRA PREMIX

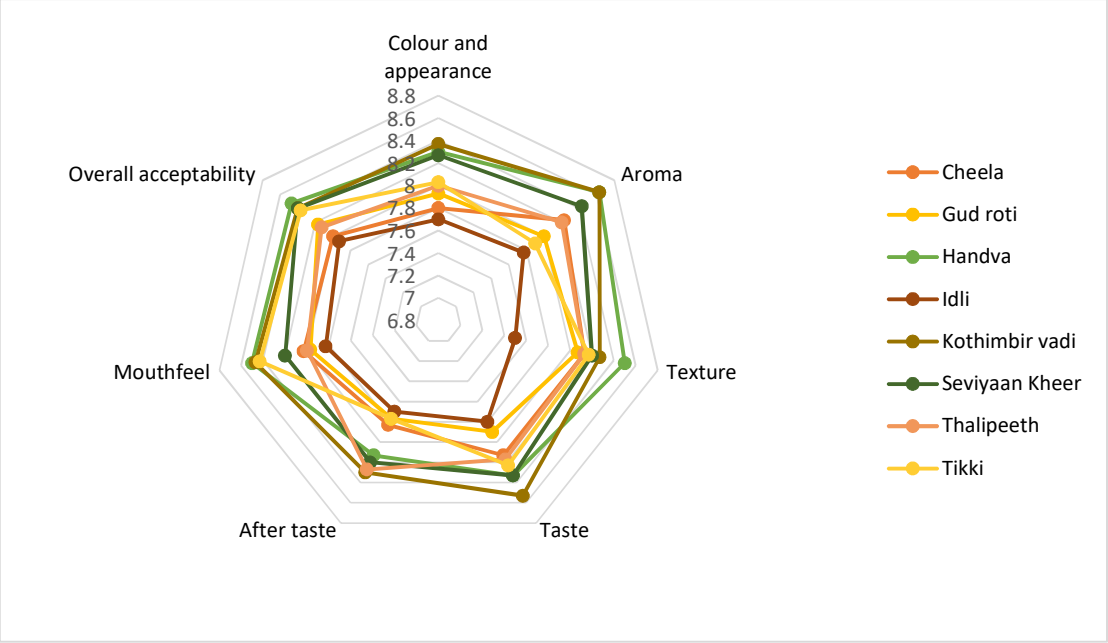


FIGURE 4.11.ii: COMPOSITE SCORES OF RECIPES MADE FROM JOWAR PREMIX

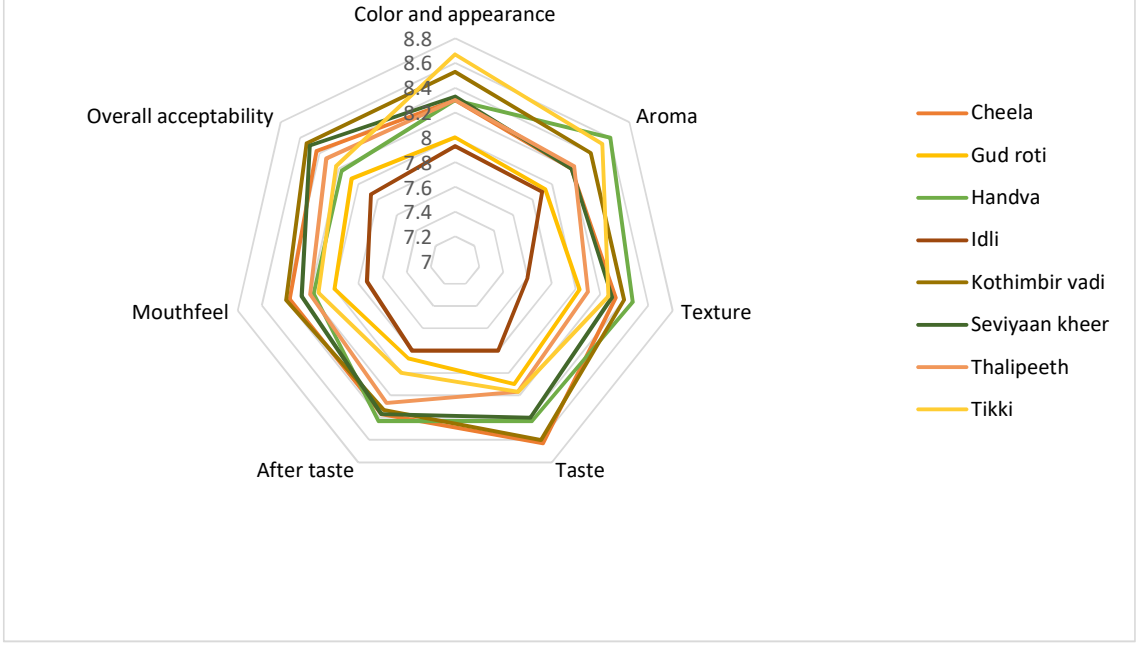


FIGURE 4.11.iii: COMPOSITE SCORES OF RECIPES MADE FROM RAGI PREMIX

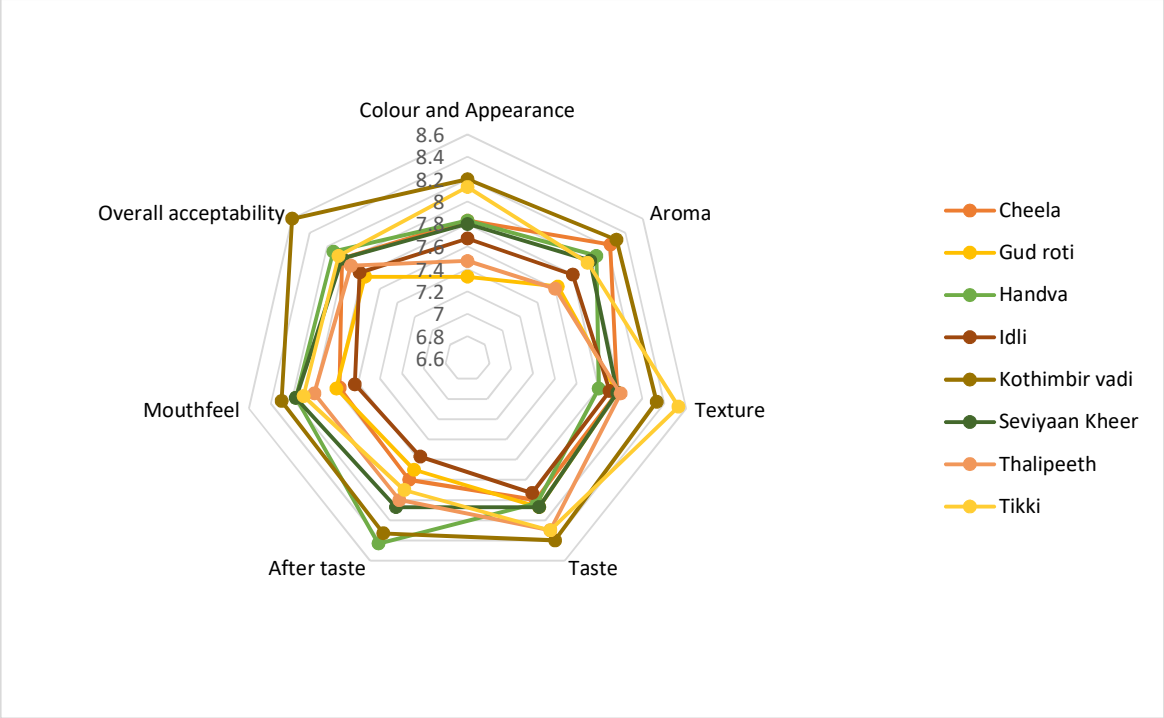


FIGURE 4.11.iv: COMPOSITE SCORES OF RECIPES MADE FROM KODARI PREMIX

FIGURE 4.11.v: COMPOSITE SCORES OF RECIPES MADE FROM AMARANTH PREMIX

SUMMARY AND CONCLUSION

Summary and Conclusion

Adequate nutrition plays a great role in optimal growth and development of every human during every stage of life. Pre-schoolers are children belonging to 3-5 years of age. This is the age where children start growing physically at a higher rate along with development of the cognitive part of the brain. Pre-schoolers also start socializing and developing a sense of self-identity. All these factors affect their nutritional requirements and also eating behaviours. Hence, it is important to focus on fulfilling pre-schoolers nutritional needs and requirements consistently to avoid conditions like undernutrition and micronutrient deficiency. It is seen that a diet lacking in dietary diversity increases the chances of children being undernourished, therefore ensuring dietary diverse diets of pre-schoolers help in improving their nutritional status.

One of the ways of increasing dietary diversity is through products which are convenient to use, as nowadays both the parents of children work which demands products that saves them time and effort. Premixes fulfil all the requirements of being a convenient and easy to use product which when manufactured while focusing on the needs of pre-schoolers can be utilized to encourage dietary diversity in their diet. Commercially available premixes lack the flexibility of being incorporated in various recipe. Hence, a need was observed for development of premixes that was made from multiple food groups and which could be incorporated in all kinds of recipe and had positive sensory properties for pre-schoolers.

Phase 1: Development and standardization of multigrain premixes.

Five multigrain premixes were developed using ingredients from three food groups – Millet, Cereal and Legume. Cereal (wheat) and legume (soybean) were the common ingredients while millet (Bajra, Jowar, Ragi, Kodari and Amaranth) were the variable ingredient. The composition of the ingredients used in the premixes was decided according to the Estimated Average Requirements (EAR) of pre-schooler children (3-5 years of age).

- Each serving of premix (30g) had 15g of millet flour, 8g of wheat flour and 8g of soybean flour:

    1. Bajra premix – Bajra flour (15g), Wheat flour (8g) and Soybean flour (8g)
    2. Jowar premix – Jowar flour (15g), Wheat flour (8g) and Soybean flour (8g)
    3. Ragi premix – Ragi flour (15g), Wheat flour (8g) and Soybean flour (8g)
    4. Kodari premix – Kodari flour (15g), Wheat flour (8g) and Soybean flour (8g)
    5. Amaranth premix – Amaranth flour (15g), Wheat flour (8g) and Soybean flour (8g)
- Mean energy content of the five premixes is 106.6 ± 1.95 kcal, mean carbohydrate, protein and fat content is 15.66 ± 0.44g, 5.38 ± 0.34 g and 2.18 ± 0.28 g respectively
- Mean iron, calcium and vitamin A content of the five premixes is 1.75 ± 0.33 mg, 35.80 ± 22.65 mg and 0.28 ± 0.30 mcg respectively.

Phase 2: Development of recipes from the premixes.

The multigrain premixes were incorporated into eight recipes. The standardization of the recipe was done with the aim of its energy and nutritional composition provides one-fourth of the total EAR of pre-schoolers. The eight recipes developed were – Cheela, Gud roti, Handva, Idli, Kothimbir vadi, Seviyaan kheer, Thalipeeth and Tikki. The nutritional content of all the recipes ranged between 295 – 325 kcal energy, 24.7 – 35.7 g carbohydrate, 7 – 13.4 g protein, 11.9 – 19.8 g fat, 2.4 – 4.64 mg iron, 66.7 – 314 mg calcium and 3.2 – 410.2 mcg vitamin A.

Phase 3: Sensory evaluation of the eight recipes made from the five developed multigrain premix.

Sensory evaluation of the recipes and its varieties were performed by 30 semi-trained panellists. Composite rating scale and 7 point Hedonic tests were used in the sensory evaluation.

1. The following observations were noticed when the composite rating test scores of individual recipes made from different developed multigrain premixes were compared:

- All the recipes made from the developed multigrain premixes were found to be highly acceptable for all the attributes by the panellists.
- Gud roti was the only recipe where significant differences were found in all the attributes.
- For cheela, significant difference was found only in colour and appearance while all the other attributes had scores similar to each other.
- For handva, idli and kothimbir vadi, all the sensory attributes had scores similar to each other with no significance difference.
- Except for colour and appearance all the other attributes between the seviyaan kheer made from the five multigrain premixes were fairly equivalent.
- The difference between the thalipeeth variation groups were significant for colour and appearance, mouthfeel and overall acceptability. The highly significant difference was mainly seen between ragi and amaranth & ragi and kodari groups only while for other premixes these attributes were similar to each other.
- For tikki, the difference was significant for colour and appearance, taste and after taste only.

- Gud roti made from amaranth premix had the highest average total score in the composite rating scale test.

2. The composite rating test scores of different recipes made from the same developed multigrain premix showed that:

- For all the recipes, the recipes made from ragi premix had the lowest scores comparatively.
- When the recipes made from the bajra premix was compared to each other, all the attributes were similar to each other except for aroma, texture and aftertaste where some differences were observed.
- Significant differences were seen between the recipes made from jowar premix with respect to colour and appearance, texture, taste and after taste only, however the total average scores were similar to each other.
- As for ragi premix incorporated recipes except for colour and appearance, aftertaste and overall acceptability, all the other attributes had similar scores.
- Recipes made from kodari premix had significant differences between them on the basis of texture, taste, aftertaste and overall acceptability only.
- Except for colour and appearance, there were significant differences in all the sensory attributes between the recipes made from amaranth premix.

3. Hedonic score for all the multigrain premix incorporated recipes were above 5 which indicates that they were accepted and liked by the sensory evaluation panellists.

4. Hedonic scores of different recipes made from the same developed multigrain premix had similar scores, which were above 5 indicating that the premixes were well accepted in form of all the recipes.

5. Serving size of all the recipes except for handva was rates as sufficient by majority of the panellists.

The present study concludes that multigrain premixes which are blends of millets, cereals and legumes can be used to introduce dietary diversity in pre-school children's diet. Salient features of this study is as follows:

- The recipes made from the developed multigrain premixes met the caloric requirement of the pre-schooler for a snack meal.
- The recipes are high in protein and calcium per serving.
- The composite rating scale scores of all the multigrain premix incorporated are above average (> 50 score out of 70)
- The 7 point hedonic scores of all the multigrain premix incorporated recipes are between 5-6 points (like slightly – like moderately).
- Except for gud roti, all the other recipes had significant difference between their variations in 2-3 attributes. This indicated that the premix can be used interchangeably without causing significant difference in the sensory attributes of the recipes.
- The highest rated recipe was amaranth premix incorporated gud roti.
- The recipes made from ragi premix had the lowest scores.
- The serving size of all the recipes except for handva were rated sufficient by majority (> 80%) of the panellist. Serving size of handva was rated more than sufficient.

Recommendations

The above mentioned results indicate that the developed multigrain premixes can be incorporated in various recipes which would help in increasing the dietary diversity in the daily diet of pre-schoolers along with fulfilling their nutritional requirement. As we are aware that India being a diverse country with respect to the dietary practices, hence the premixes that have been developed using different grains so as to take care of this diversity as well as region specific recipes can be developed as per the dietary habits of the population. Due to the pandemic condition, pretesting of recipes by mothers of pre-schoolers and supplementation wasn't possible. Further, studies can be done to supplement these multigrain premixes to children belonging to pre-school age group and its effect on their nutritional status.

The five multigrain premixes developed can be recommended to be provided as Take Home Ration (THR) for children belonging to 3-5 years' age group under various government schemes.

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APPENDICES

Appendix I

Sensory Evaluation Card

Sensory Evaluation Card

Dear panel members, I, Sheetal Pasi, conducting this sensory evaluation of recipes incorporated with premixes developed for pre-school children as part of my MSC dissertation 2020-2021 under the guidance of Dr Swati Dhruv. I request you all to kindly fill up the form with the required details. Thank you

* Required

1. Panelist's name *

2. Mobile number

3. Age

4. Is the portion size sufficient for a pre-schooler? *

Mark only one oval.

- ◯ More than sufficient
- ◯ Sufficient
- ◯ Not sufficient
- ◯ Less than sufficient
- ◯ Don't know

Composite Rating Scale

5. Taste and rate the sample for its Colour and Appearance *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Very poor	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very good

6. Taste and rate the sample for its Aroma *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Very poor	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very good

7. Taste and rate the sample for its Texture *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Very poor	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very good

8. Taste and rate the sample for its Taste *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Very poor	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very good

9. Taste and rate the sample for its After Taste *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Very poor	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very good

10. Taste and rate the sample for its Mouthfeel *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Very poor	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very good

11. Taste and rate the sample for its Overall Acceptability *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Very poor	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very good

7- Point Hedonic Rating

12. Overall, how much do you liked this product *

Mark only one oval.

- ◯ Like very much
- ◯ Like moderately
- ◯ Like slightly
- ◯ Neither like nor dislike
- ◯ Dislike slightly
- ◯ Dislike moderatei
- ◯ Dislike very much

Appendix II

CONSENT FORM FOR SENSORY EVALUATION

STUDY TITLE: Development of nutritionally dense premixes for improving the dietary diversity among pre-schoolers.

INVESTIGATORS

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PURPOSE OF THE STUDY

Pre-schoolers are an age group that grow rapidly physically and mentally. One way to ensure their optimal growth and development is to provide them their nutritional requirements. Increasing dietary diversity among diets of children has shown prevention of different forms of malnutrition. Developing a nutritionally dense premix which is made with an intention of increasing dietary diversity among pre-schoolers is the need of the hour as more and more mothers of these children are entering workspaces which increases demand of convenience foods.

BENEFITS AND RISKS

The nutritionally dense premixes and the recipes incorporating them will help in improving dietary diversity among pre-schoolers which in turn ensures prevention of all forms of malnutrition. It also provides ease and convenience in preparing and thus can be done by anyone.

PROTOCOL OF THE STUDY

If you decide to join this study you will be required to taste the developed nutritionally dense premixes and the recipes incorporating them and carry out the sensory evaluation using the hedonic rating scale and composite rating scale. A series of 3-4 premixes will be developed and from each of them 2-3 recipes will be developed, sensory evaluation of which will be carried out on different days.

COSTS

The study only requires your time and cooperation. All the costs incurred will be borne by the researcher and there is no financial compensation for your participation in this research.

PARTICIPANT'S STATEMENT

I certify that I have read, or had read out to me, and that I have understood the description of the study. By signing this form, I am attesting that I have read and understood the information given above.

I give my consent to be included as a subject in the study being carried out by Ms. Sheetal Pasi under the guidance of Dr. Swati Dhruv of the Maharaja Sayajirao University of Baroda to determine the acceptability of nutritionally dense premixes and the recipes incorporating them.

I understand that the study requires the participant to taste premixes incorporated recipes. I have had a chance to ask questions about the study. I understand that I may ask further questions at any time. I have been explained to my satisfaction the purpose of this study and I am also aware of my right to opt out of the study any time.

_____

Participants name and signature Date:

Class: _____

Whatsapp number: _____

APPENDIX III

Multigrain Premixes Incorporated Recipes Booklet