



DEVELOPMENT AND STANDARDIZATION OF LEGUME AND MILLET-BASED NUTRIENT-DENSE SNACKS TO COMBAT MALNUTRITION IN SCHOOL-GOING CHILDREN IN INDIA

KALAI AMUTHA G.,**MS. SNEHA S.,****Dr. P.S. PRATHIBHA**

PG SCHOLAR

ASSISTANT PROFESSOR

PROGRAM HEAD

DEPARTMENT OF FOOD SCIENCE, NUTRIENT AND DIETETICS

Dr.MGR EDUCATIONAL AND RESEARCH INSTITUTE, CHENNAI, INDIA.

Abstract

Malnutrition is a pressing concern, especially in India, and the ongoing efforts to combat it through initiatives like the Integrated Child Development Services (ICDS) scheme are full-fledged. The development of cost-effective children-centered snacks that are nutritionally balanced has drawn attention among researchers and nutritionists. This study focused on assessing the acceptance and cost-effectiveness of laddu variations incorporating pearl millet, green gram, and peanuts as major ingredients, offering insights into the promotion of nutritious and budget-friendly snacks to address nutritional and economic obstacles in food security. Millets being the powerhouses of nutrients, are the most underrated ingredient in the development of cost-effective snacks. This study utilizes pearl millet and green gram to prepare nutrient-dense laddu in various proportions to identify the most acceptable product. The three samples, sample A, sample B, and sample C are then subjected to sensory analysis using a 5-point hedonic scale. In conclusion, sample A (pearl millet – 100g, green gram – 100g) demonstrated significantly higher overall acceptance than the other samples in this study. This low-cost, nutritious laddu made from locally sourced ingredients presents a timely solution to addressing malnutrition challenges in India. Its widespread adoption has the potential to positively impact public health outcomes and combat malnutrition effectively.

KEYWORDS: pearl millet and green gram laddu, snack for school children, cost-effective and nutrient-dense.

1. Introduction:

Malnutrition occurs when individuals lack essential nutrients due to factors like poverty, reduced dietary intake, or poor absorption. It leads to various health issues, psychological problems, decreased abilities, and low energy levels. Malnutrition in India is a critical issue, with nearly half of all children affected and high rates of maternal and child mortality. According to a recent study conducted by the National Family Health Survey (NFHS) in 2020, malnutrition continues to be a significant public health concern in India. The survey revealed that approximately 38.4% of children under the age of five are stunted (low height for age), indicating chronic malnutrition, while 21% are wasted (low weight for height), reflecting acute malnutrition (NFHS, 2020). Despite some reduction in undernutrition rates, challenges persist, including the high prevalence of underweight children. (J Narayan et al., 2019).

Factors affecting school-going children can include socio-economic status, family support and involvement, access to resources such as nutritious food and healthcare, the quality of education provided, and the presence of a safe and supportive learning environment. (Singh B.P et al.,2021) These factors collectively influence a child's academic performance, physical health, emotional well-being, and overall development during their school years. (Rani, P et al.,2016.)

Millets are nutritional powerhouses, packed with essential nutrients vital for human health. Rich in dietary fiber, they aid digestion, promote satiety, and help maintain a healthy weight. Millets are also excellent sources of protein, essential vitamins, and minerals like iron, calcium, magnesium, and zinc, crucial for various bodily functions and immune system support. Their inclusion in diets can bridge nutrient gaps and enhance overall nutritional status. (Gagan Tripathi et al.,2023). Pearl millet (*Pennisetum glaucum L.*) holds significant potential in addressing food security and nutrition challenges due to its resilience and rich nutritional content. It offers numerous benefits, including promoting biodiversity and contributing to climate-smart agriculture. Despite its nutritional value, challenges in cultural acceptance, processing, and marketing persist. By incorporating technology, effective marketing strategies, and policy initiatives, pearl millet can play a vital role in sustainable food security. Moreover, efforts to develop biofortified varieties enriched with zinc and iron, along with enhancing demand and market-led extension, are crucial for promoting cultivation and consumption. Multidisciplinary approaches involving breeding, genomics, bioinformatics, and

biotechnology are necessary to harness the beneficial attributes of pearl millet and ensure nutritional security in the face of changing climates. (Dr. Kumar Amit et al., 2021)

Legumes are widely available across the globe, making them a practical and valuable source of protein, minerals, vitamins, and bioactive compounds for both humans and animals. Legumes offer a rich array of nutrients essential for health, making them a versatile and sustainable option for enhancing diets and supporting overall well-being. (marcin sonta et al.,2020) Green gram, also known as mung bean (*Vigna radiata L. Wilczek*), is a significant grain legume renowned for its nutritional value. It is rich in digestible protein, amino acids, sugars, minerals, soluble dietary fibers, and vitamins. This nutrient-dense legume offers various health benefits and is a valuable addition to diets, providing essential nutrients for overall well-being. (Mercy Kiende Muchomba et al., 2023)

India is combating malnutrition through a multifaceted approach, leveraging various national and state-level schemes. These initiatives aim to address the complex challenges of undernutrition and micronutrient deficiencies prevalent across diverse regions. National programs such as the Integrated Child Development Services (ICDS), Mid-Day Meal Scheme, and the National Nutrition Mission (POSHAN Abhiyaan) are pivotal in providing essential nutrition interventions. The Integrated Child Development Services (ICDS) scheme is the world's largest community-based program aimed at improving child health and development. It includes a combination of pulses, cereals, oil, vegetables, and sugar to provide balanced nutrition to children. Some Anganwadi Centers (AWCs) also offer ready-to-eat meals as part of the program. (Y Sachdev et al., 2001). The National Programs of Mid-Day Meal in Schools as well as initiated in October 2007,' is ordinarily referred to as the Mid-Day Meal MDM Scheme. One of its base objectives is to address hunger and malnutrition and improve socialization among castes (Arunkumar R et al., 2023)

With combating malnutrition using cost-effective ingredients as the central focus, this study revolves around developing a nutrient-dense laddu and performing the sensory analysis to identify the most acceptable variation.

2. Materials and Methods:

2.1 Raw materials

Raw materials such as Pearl millet, green gram, peanut, jaggery, and ghee were purchased from the local market in Chennai.

2.2 Methodology:

2.2.1 Formulation of Nutrient-Dense Snacks:

The methodology for preparing the three variations of laddu involves several steps "Figure 1". Firstly, the pearl millet is soaked for 8 hours. After soaking, the pearl millet, green gram, and peanuts are roasted separately. Once roasted, the pearl millet and green gram are ground into flour, while the peanuts are cracked. Formulation of the laddu is then carried out for three variations as given in (Table 1). The pearl millet, green gram, peanuts, and ghee are mixed in a bowl. Meanwhile, water is heated, and jaggery is dissolved in it to form a syrup. This syrup is then added to the mixed bowl, and the ingredients are thoroughly combined to form laddu "Figure 2". The same process is carried out for all the samples, each following their respective formulation variations.

Table 1: Formulation of nutrient-dense snack

INGREDIENTS	SAMPLE A	SAMPLE B	SAMPLE C
pearl millet	100g	140g	60g
green gram	100g	60g	140g
Peanut	50g	50g	50g
Jaggery	50g	50g	50g
Ghee	15ml	15ml	15ml
Water	50ml	50ml	50ml

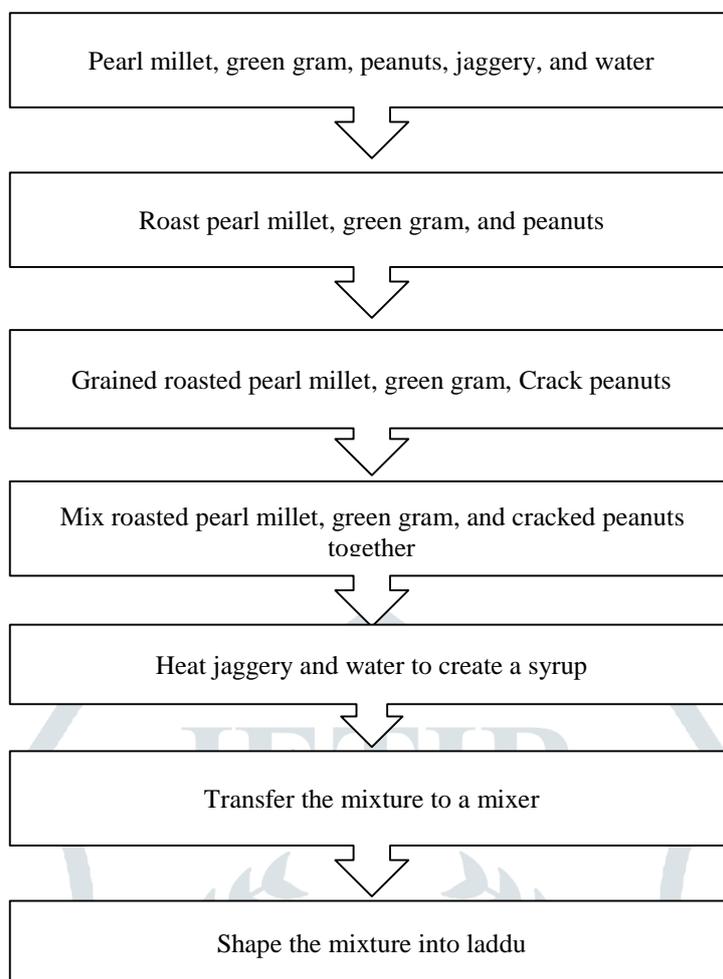


Figure 1: flow chart for preparation of nutrient-dense snack



Sample A

Sample B

Sample C

Figure 2: Three variations of laddus

2.2.2 Sensory analysis:

The sensory analysis of three variations of laddu samples was conducted using a 5-point hedonic scale with fifty untrained participants. This method aimed to evaluate the overall liking of each laddu variant based on taste, texture, aroma, and appearance. The scores provided valuable insights into consumer preferences and perceptions, aiding in refining the laddu recipes to meet consumer expectations and enhance product satisfaction.

2.2.4 Statistical analysis:

The data obtained through sensory analysis were analyzed descriptively using mean and standard deviation.

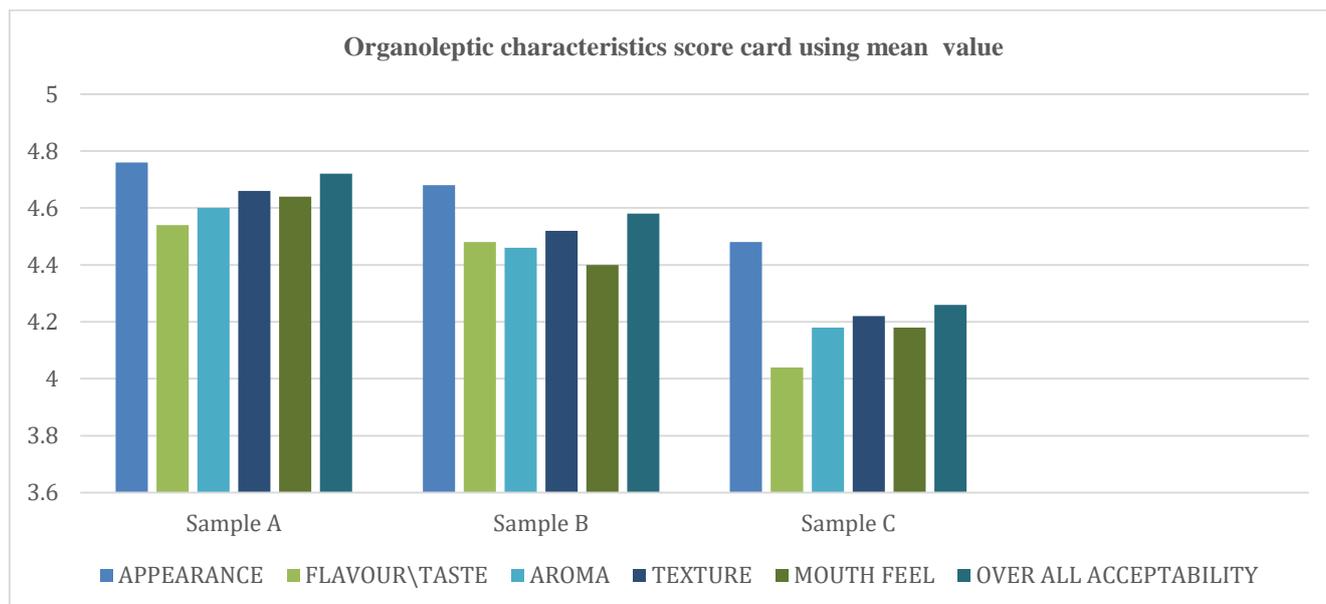
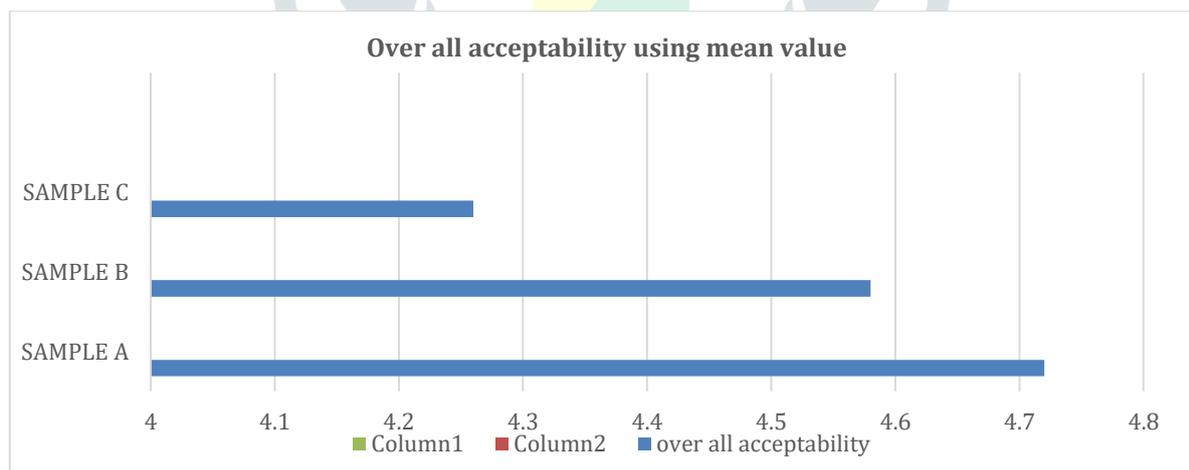
3. Result and discussion:

3.1 Organoleptic characteristics of snack laddu:

The organoleptic characteristics, including color and appearance, flavor/taste, aroma, texture, mouthfeel, and overall acceptability, were evaluated for nutrient-dense laddu. Organoleptic characteristics evaluated by mean and standard deviations are given in (Table 3). The analysis indicates that sample A exhibited the highest overall acceptance among the three samples, suggesting that it was preferred by the participants in terms of sensory attributes "Figure 4".

Table 3: Organoleptic characteristics evaluated by mean and standard value

samples	appearance	flavor/ taste	aroma	texture	mouthfeel	overall acceptability
sample a	4.76 ± 0.47	4.54 ± 0.61	4.6±0.57	4.66 ± 0.59	4.64 ± 0.59	4.72 ± 0.49
sample b	4.68 ± 0.47	4.48 ± 0.57	4.46±0.67	4.52 ± 0.67	4.4±0.67	4.58±0.53
sample c	4.48±0.64	4.04±0.80	4.18±0.69	4.22 ± 0.73	4.18 ± 0.77	4.26±0.75

**Figure 3:** score card of organoleptic characteristics**Figure 4:** Overall acceptability of the nutrient-dense Laddu variations

4. Conclusion:

In conclusion, the sensory analysis of three variations of laddus made with pearl millet and green gram legume revealed that sample A, with equal amounts of pearl millet and green gram, emerged as the most preferred option. Conversely, sample B, with a higher proportion of pearl millet, and sample C, with increased green gram legume, received lower acceptance ratings. The cost-effectiveness of laddu formulation can enhance their feasibility as nutritious and affordable snacks, addressing both nutritional and economic challenges. This nutrient-dense laddu can be incorporated into the central and national schemes focusing on combating malnutrition in India to alleviate the nationwide prevalence and ensure food security.

5. Acknowledgement:

We extend our heartfelt gratitude to Thiru A.C. Shanmugam BA. BL, Founder & Chancellor, and the entire leadership team at Dr. M.G.R. Educational & Research Institute for their unwavering support and facilities during our M.Sc. in Food Science, Nutrition, and Dietetics, enabling us to complete our project. Special thanks to Er. A.C.S. Arun Kumar, B.E., President; Thiru A. Ravikumar,

Secretary; Prof. Dr. S. Geetha Lakshmi, Vice Chancellor; as well as Provost, Rector, Pro Vice-Chancellor, and Registrar for their encouragement.

Additionally, we acknowledge Mr. M. Prabu, Joint Registrar, Humanities and Sciences, and Dr. P.S. Prathibha, Deputy Dean and Program Head, Department of Food Science, Nutrition, and Dietetics, for their support throughout our project journey.

We extend our deepest gratitude to Ms. Sneha S, Assistant Professor in the Department of Food Science, Nutrition, and Dietetics, for her unwavering support, guidance, encouragement, and valuable suggestions that contributed to the successful completion of our study. Additionally, we express our heartfelt thanks to our other professors, faculty, friends, and participation for their indispensable help, support, and care throughout our academic journey.

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