ISBN: **978-93-343-9865-6**

NSEI/2025/36

CREATION, NUTRITIONAL ANALYSIS, AND SENSORY EVALUATION OF A MILLET-HERBAL COMPOSITE FLOUR FROM LOCAL SOURCES TO PROMOTE RURAL HEALTH

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Abstract- In the rural areas often millets are very much readily used and are very popular among the rustics. But these preperations lack essential nutrients and and is generally deprived of balanced diet. Over the years Malnutrition has been one of the greatest enemy of the rustics due to very limited and low access to diverse and affordable food products. " The goal of this research is to create a nutrient-dense, all-purpose flour blend that rural households can readily use in everyday dishes like roti, chapati, khichdi, rice porridge, and more. Ingredients such as finger millet, barnyard millet, black rice, soybeans, pumpkin seeds, and immune-boosting herbs like turmeric, fenugreek leaves, and moringa leaves are used to make the blend of the flour. Our main objective is to raise rural populations nutritional status without forcing them to alter their customs around food preferences or cooking techniques and fostering them to go on with their food habits and inventing a product which is easily acceptable to them. With inexpensive, readily available ingredients, this invention blend provides an effective and workable way to fight malnutrition, boost immunity, and encourage sustainable diets,manage time and costs and labour. Long-term storage of the this flour mixture ensures convenience and preparedness in times of food scarcity or emergency. Nutritional analysis and sensory assessment verify that the mix is very beneficial and acceptable is a very promising and mediation in reinforcing rural health and development.

Keywords: Millet-based nourishment, herbal additives, immunity enhancing, all purpose, fighting malnutrition, long term storage, eco-friendly solutions, resource efficient

I. INTRODUCTION

Millets are a collective term referring to many small-grained cereals (belongs to grass family). They are Gluten-free and nutrient-rich. These are the staple diets of Asian and African countries, especially in developing countries like Mali, Nigeria, and India with 97% of production. The crop is favoured for its productivity and short growing season under hot, dry conditions. They are highly tolerant of drought and other extreme weather conditions and have a similar nutrient content to other major cereals. Millets respond to high moisture and fertility. On a per-hectare basis, millet grain production can be 2 to 4 times higher with use of irrigation and soil supplements. Improved varieties of millet with enhanced disease resistance can significantly increase farm yield.

Millets are known as the oldest food grains known to mankind and are cereal grains used for domestic purposes. Humans consume millets for about 7,000 years and potentially had "a pivotal role in the rise of multi-crop agriculture and settled farming societies". In Indian, nearly 1/3rd the population's staple diet is millets. According to doctors and scientists, millets are the best choice for nutrition, but rural and conventional people have limited access to them. The nutritional quantity is four to five times elevated than that of staple crops like rice and wheat (Reddy Venkata Ram Teja *et al*., 2020). Millets are well recognized for their rich content of Niacin, which is essential for maintaining healthy skin and organ function. It has a good content of calcium(0.38%), dietary fiber (18%), and phenolic compounds (0.3-3%) (Palanisamy Bruntha Devi *et al*., 2014). Millets are highly beneficial to human health. Because of

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the high fiber content in millet, it is an excellent choice for promoting digestive health. It prevents constipation and the risk of colon cancer. It also has the essential fats, which reduce the bad cholesterol and risks of other heart diseases. Millets do not contain allergens, so patients with asthma can go for the millets because they do not cause wheezing. Millets act as an antioxidant because they help to detoxify the human body.

Mostly rural people suffer from poverty, due to which they can't afford a diversified and balanced diet. This is the main reason why rural people suffer from malnutrition. Mostly women and children suffer from Anemia. Also, children suffer from weak bones and stunted growth. Digestion problems and risk of gastrointestinal issues are also seen. Increased rates of lifestyle diseases such as obesity, diabetes, etc. Poor diets lead to increased medical expenses. Without millet cultivation, villagers face a large amount of crop failure, a shortage of staple foods, which leads to dependency on government or market interventions for supplies. This will also lead to monoculture practices that mainly depend on the water-intensive crops such as wheat and rice.

Millet-based foods are highly beneficial for the rural lifestyle. This is because of the following reasons:-

- In addition to being very nutrient-dense (containing fiber, iron, calcium, and vital vitamins), it is also reasonably priced, making it affordable for rural residents with low incomes. Arid regions, drought-prone areas, and less fertile lands—all of which are prevalent in villages—can be used to grow millets
- . The total cost of farming is decreased because they only need a small amount of water and a few inputs, such as pesticides and fertilizers. Consuming millets on a regular basis will reduce lifestyle diseases like obesity and diabetes..Since urban companies always demand healthy and natural foods, villagers are starting niche markets by branding millet products as organic, traditional, and nutritious.
- Producing and selling of millet-based food items will open a large number of income pathways for farmers, women's self-help groups, and rural entrepreneurs.

Now, coming to our research, which mainly focuses on the formulation of the composite flour with an herbal mix. A millet-based composite flour is basically a mixture where various types of millets are combined with other cereals, pulses, or any other type of functional ingredient to increase its nutritional quality and improve its various functional properties. Millets v.i.z Finger millet (ragi), Pearl millet (bajra), Little millet, Branyard millet, Foxtail millet, etc. This composite flour, which is mainly made up of Finger millet, i.e., Ragi (50%), Black rice (15%), Barnyard millet (15%), Black soyabean (15%), Pumpkin seeds (5%). All these elements are rich in Calcium(Ca), Fiber aids, Proteins, Minerals, and Anti-oxidant properties. The addition of 50% of the Finger millet (Ragi) will increase the taste quality and also improve the functional properties. In order to increase the functionality of this flour, we will add an herbal mix. Herbs will support energy metabolism, bone and skin health, and immune function because they are a good source of minerals, vitamins, and antioxidants. Additionally, these herbs will lower the chance of developing long-term conditions like cancer, heart disease, and neurological disorders. Amruthaballi (1.0%), Clove (0.5%), Horagone leaves (2%), Dried ginger (2%), Indian borage (2%), Turmeric (2%), Moringa (1%), Amla (0.5%), and Fenugreek leaves (1.0%) are among the herbs.This composite flour is of great use. These are as follows:-

- Porridge: It can be used as a staple diet, like porridge, and in Gruel. Mixing this flour with water or milk and then cooking it on a low flame will give a delicious porridge.
- Roti/ Chappati/ Flatbread: To make Rotis or Fulkas, knead the flour into a soft dough and roll it out with a little pressure.
- Ladoo/ Energy balls: Giving the flour a round shape and combining it with nuts, ghee, oils, and jaggery will create wholesome, delicious, and nourishing energy balls or ladoos.

ISBN: **978-93-343-9865-6**

- Dosa /Uttapam: Mixing the composite flour with fermented batter will make a different texture of Dosa and Uttapam.
- Namkeen mixture: Spicy and mouth-watering snacks such as Chakli or Murukku can be made.

Also, the preservation of this flour doesn't require much struggle. These are as follows:

- Drying and removing the moisture content of the ingredients, as moisture provides a suitable environment for bacterial growth and will lead to spoilage.
- Also, slight roasting of the ingredients will automatically enhance the taste of the flour, leading to a good recipe.

II. STUDIES AND FINDINGS:

Different policy initiatives taken by governments and multilateral agencies have increasingly focused on nutrition, given the high returns from investing in. Despite this increasing interest in nutrition, for many developing countries, there is a dearth of detailed studies focusing on nutrient intake (Haddad et al., 2015). In the context of India, a country with high levels of stunting and wasting, recent national surveys on nutrition suffer from issues of comparability and lack of coverage, particularly for regions with high nutritional deficiencies (John, Knebel, Haddad, & Menon, 2015). This paper uses primary village-level data from a poor region in India to investigate both macro- and micro-nutrient consumption. Specifically, we study the consumption of three macronutrients (calories, protein, and carbohydrates) and two micronutrients (calcium and iron). In addition to quantifying the level of nutritional intake in the village, we examine the causal factors that impact nutrient consumption.

TABLE: Parameters affecting nutritional Intake in Rustics.

PARAMETERS	PERCENTAGE	OBSERVATION
Households dependent on cereals	95%	Rice and wheat are the primary staple foods
Low protein intake	68%	The majority were reported to have limited access to pulses or animal proteins
Millet is awared but lacks usage of them	52%	Millets are seen as traditional, but are inconvenient to cook
Open to trying new mixes and recipes when offered	74%	Most rustics have a positive response to trying new products when they are affordable and easily usable
Facing Storage issues	81%	Lack of proper storage leading to food spoilage resulting to economic harm

Elaborate statistics on the households' inatke of the different food categories were studied and researched. Bulk of food consumption mainly occupied by cereals and vegetables. Among the major food groups, meat, eggs, and fish together have the lowest average monthly levels of consumption at just 0.61 kg.

A survey found that a very large and significant percentage of people lack essential nutrients, particularly proteins, iodines, vitamins, minerals, iron, and calcium. Approximately 68% of people in the countryside were reported to have insufficient protein intake, while 52% showed a lack of awareness about sources of essential vitamins and minerals Notably, women and children suffer the most. This poor diet aggravates fatigue, malnutrition, and other conditions. Millets are ancient grains that have been cultivated for many years and are renowned for their high nutritional content, climate adaptability, and tough resilience against all environmental stressors and strains. Despite being traditional sources, they

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are sometimes disregarded in modern diets, especially in rural areas where malnutrition is still a problem. However, they are now playing a crucial role in improving food security, sustainability, and health. Millets like finger millet (ragi), little millet, and foxtail millet can greatly improve the health of people who are already at risk because they are very high in important nutrients like iron, calcium, fiber, and protein. Finger millet is described as imthe most nutritious among all the major cereals and was nominated as super cereal yunited states of national academics [Andargie, et al. 2024].

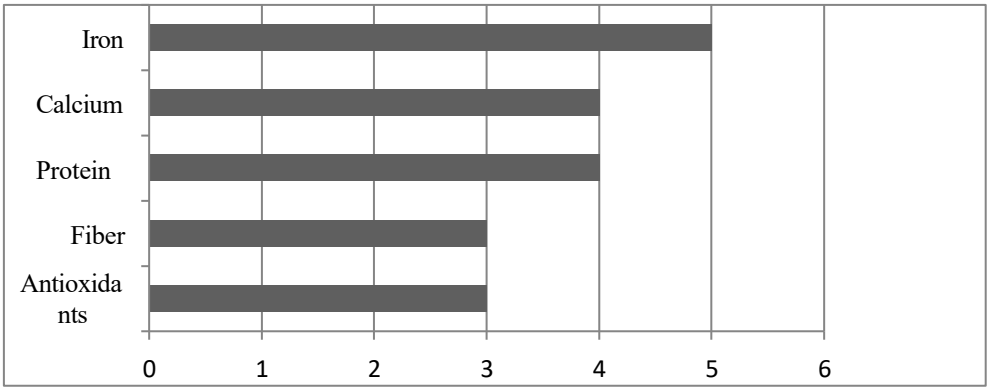


Table: Nutritional content of various Millets.

The scale of the graph represents arbitrary values from 0 to 6 where the greater value implies greater nutritional content and vice versa.

Formulation of Finger Based Millet Flour Mix:

For the preparation of the flour finger millet-based composite flour mix, finger millet was substituted with other ingredients such as black soya bean, black rice, barnyard millet, and pumpkin seeds. Each of the ingredients was cleaned, dried, and powdered separately to prepare the flour mix. Then all the herbs used in the mixture were prepared by removing the moisture content and drying them. Then the powdered ingredients were measured at different levels and were incorporated at different proportions in the flour. The flour was developed by substituting finger millet at different ratios (70:30; 60:40,50:50, 40:60). The Best composition was identified according to taste, texture, and nutritional value. Developed mixes were analysed, and gruel was prepared for sensory analysis, and the Nutritive value of the best was taken and subjected to the herbal mixture.

Table.1. Formulation of the Composite Flour Mix

Ingredients	**CFT1 (70:30)**	**CFT2 (40:60)**	**CFT3 (50:50)**	**CFT4 (40:60)**	**Nutitional Value**
Finger Millet	70	60	50	40	High in Calcium
Black Rice	15	15	15	15	Iron, antioxidants and fibre
Barnyard millet	5	10	15	20	Fibre, Iron, Magnesium
Black Soyabean	5	10	15	20	Protein, fibre, folate
Pumpkin seeds	5	5	5	5	Healthy fats zinc Mg

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Functional properties such as oil absorption capacity,water absorption capacity, swelling power, and swelling capacity were analyzed for finger millet-based and wheat-based composite flour to select the best combination.

III. DEVELOPMENT OF HERBAL MIXTURE:

Development of Herbal mix: Different herbs such as Amruthaballi, Honagone leaves, Indian borage, turmeric, dried ginger were procured. Herbs were cleaned and dried to remove moisture content. Further the herbs made into fine powder by using mixer and sieved with mesh size (212 µm).

Table:- Various Composition of Herbal Mixture

Herbs	HMT1	HMT2	HMT3	Nutritional value
Amruthaballi	1.75	1.5	1.0	Rich in antioxidants Vitamin A and C
Honagone leaves	2	2	2	Iron, fibre and antioxidants
Dried Ginger	2	2	2	Anti-inflammatory aids digestion
Indian Borage	2	2	2	Essential oils, Respiratory Health
Turmeric	2	2	2	Curcumin, Anti-inflammatory ,Antioxidants
Moringa Leaves	1.5	1.0	1.5	Protein, Calcium, Iron Vitamin C
Fenugreek Leaves	1.0	1.5	1.0	Fiber, Iron, helps regulate blood sugar.

Herbal mix was standardized by adding selected herbs with different composition (Table 2) and product was evaluated for sensory evaluation by using nine point hedonic scale. Further best composition was selected for best yield subjected for sensory evaluation by a group of 15 trained panel members in the form of kashaya.

IV. CONCLUSION

This research study demonstrates the significant potential in enhancing the nutrient profile, functional properties, and health advantages of conventional cereal-based This research study on millet-based composite flour incorporated with herbal products. Since millet is rich in dietary fiber, iron, protein, calcium, essential minerals, and bioactive compounds, when combined with the therapeutic properties of several herbs, it creates a perfect blend that can help alleviate malnutrition, enhance immunity, and offer preventive benefits against lifestyle diseases. This composite flour formulation exhibits good physical characteristics, acceptable sensory attributes, and increased nutrient density, making it suitable for a wide range of food applications. Additionally these blends encourages the use of underutilized crops, supports sustainable agriculture, and presents chances for value addition in both urban and rural food systems. Furthermore, the use of herbs and millet promotes biodiversity and the blending of traditional eating customs with contemporary diets. All things considered, millet-based herbal composite flour is a promising ingredient for functional foods that fits in with current nutritional needs and health trends, promoting improved dietary interventions, food security, and the creation of functional foods.

ISBN: **978-93-343-9865-6**

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