



# Millet: A Promising Crop for Food and Nutritional Security of Urban and Rural Households

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## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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## ABSTRACT

The Tumakuru district of Karnataka's small millets-consuming households were the study's focus from 2021 to 2022. The study looked at their food consumption patterns, nutrition, and overall health. Based on primary data from 60 households, 30 from each of the urban and rural areas were conducted. The results demonstrated that, consumption of small millet was higher in the high-income group (>1,00,000) in urban areas due to health and nutrition consciousness across all income groups. The per capita consumption of small millets was relatively higher in rural area (2.2 kg/month) as compared to urban area (1.4 kg/month). While 57 per cent of rural households ate millets as a cultural and dietary practice, 40 per cent of urban households to control their blood sugar levels. Energy from the consumption of small millets, such as ragi, is produced in rural areas. About 67 per cent of households in urban areas reported that eating small millets helped them control their blood sugar levels and prevent diabetes, while 80 per cent of farmers in rural areas

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said that eating small millets kept them alert and energized all day. The amount of small millets consumed and the nutritional and health status of rural and urban households are both improved by policy initiatives such as the addition of small millets to the Public Distribution System (PDS), the Mid Day Meal program, and raising public awareness of the health and nutritional benefits of small millets consumption.

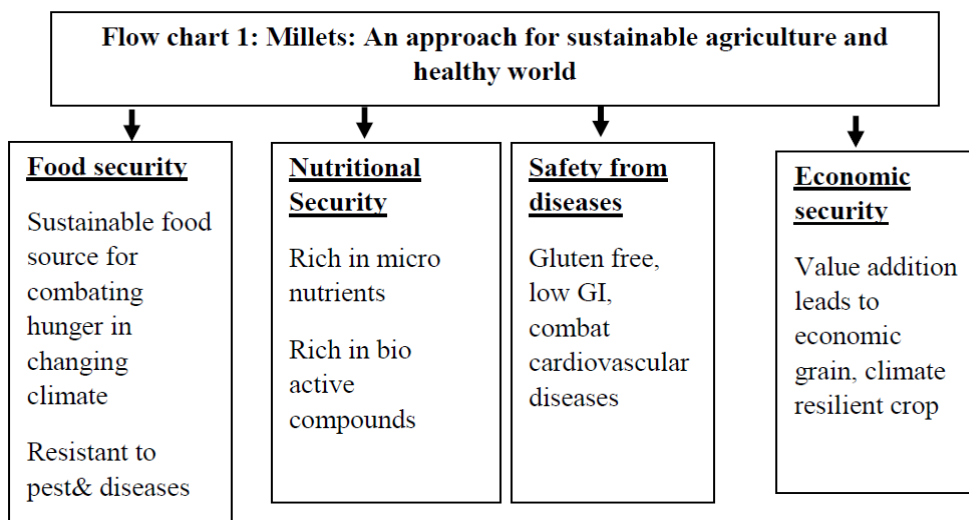
**Keywords:** Millets; dry lands; nutrition; food consumption pattern.

## 1. INTRODUCTION

A diverse genus of small-seeded grasses known as millets are grown as grain or serial crops for human consumption and animal fodder all across the world. Ancient Chinese, Indian, European, and African archeological sites have revealed millet grains, which were once employed for storing grains and seeds. The two states in India with the highest consumption of tiny millets in rural regions are Assam (18.82 kg/hsh/m) and Bihar (18.69 kg/hsh/m). Madhya Pradesh has highest area of small Millets (32.4%) followed by Chhattisgarh (19.5%), Uttarakhand (8%), Maharashtra (7.8%), Gujarat (5.3%) and Tamil Nadu (3.9%). "Millets have been a good part of the staple diet among many communities across the world and are known for their potential health benefits which includes anti diabetic properties and low glycemic index in millet-based food product which may be helpful in reducing the post-paid glucose level and glycosylated haemoglobin. Policy-makers have contributed to this by keeping millets largely out of the scope of both official research, development and price support programmes. Continued neglect hastens the loss of genetic diversity and traditional knowledge regarding the production, processing and use of millets. Production is inefficient

because of lack of suitable high- yielding varieties, poor quality seed and following traditional and unimproved cultivation practices. Inefficient traditional processing methods forced the farmers to shift from cultivation of millets to other crops. In addition, non-availability of attractive recipes for adding value, lack of awareness about health and nutritional value of millets, poor integration of markets are the major reasons to push small millets into ever marginal areas" [1].

However, in the recent years' millets are gaining importance in modern agriculture because of greater benefits in terms of lower water requirements, adaptation to climate change and marginal soils, along with increasing demand for millets in both urban and rural areas. Promotion of millets production by driving consumer demand and connecting the whole value chain including backward and forward linkage through conscious efforts at national and state level is likely to contribute substantially to fight against targeted hunger and mitigate the effect of climate change in the long run. A balanced approach to bring these crops back in the public consciousness will go a long way to solve some of the major food issues like lack of dietary diversity in the country.



## 2. METHODOLOGY

The present study was undertaken in Tumkuru districts of Karnataka during 2021-22. The study area was selected based on secondary data. Tumkuru is one of the major districts in Central Dry Zone of Karnataka intensively promoting small millets under different schemes and programmes. "Simple random sampling technique was employed for the selection of millet consuming households. Primary data was compiled from 30 households each from urban and rural areas for analyzing the food, nutrition and health status of households. The 24 hour recall method was employed to workout the calorie and nutrient intake of the urban and rural households by adjusting for egg, meat and fruits intake from households' monthly consumption. Thus, all the calorie and nutrient intake values are based on adjusted 24 hour recall method and not on the basis of 24 hour recall method. The amount of energy and individual nutrients like protein, iron, calcium, fat, riboflavin, niacin, thiamine, vitamin C and carotene consumed were worked out using the standardized food composition tables" [2,3] and this was compared with the Recommended Dietary Allowance (ICMR-NIN,2010).

## 3. RESULTS AND DISCUSSION

**Socio-economic characteristics of sample households:** In urban areas, the average age of consumers was 43 years, while in rural areas, it was 47 years. About 40 per cent of the consumers were in the income group of more than Rs. 1,00,000 per annum followed by 30 per cent in the group of Rs. 50,000-1,00,000 per annum, 13 per cent of households were having income in the range of Rs. 30,000-50,000 per annum and remaining 17 per cent of households had income of less than Rs. 30,000 per annum. In rural area 47 per cent was generated the income range of Rs. 30,000-50,000 per annum and 37 per cent generated income lower than Rs. 30,000 per annum (Table. 1). In urban area, the consumption of small millets was more in high income group (> 1,00,000) because of consciousness towards health and nutrition. The results are in contrast with the study conducted by Basavaraj *et al.*, (2010), across income classes, pearl millet was consumed mainly by the low and middle income groups. The higher income group accounts for less than 10 per cent of total pearl millet

consumed as food in rural areas and less than 5 per cent in urban areas. About 46 per cent of pearl millet in urban India is consumed by low income households.

### **Details of small millet consumption in the study area:**

In urban areas, the average monthly consumption of small millets per family was 5.42 kg, while in rural areas, it was 11.04 kg (Table 2). In comparison to urban areas, where per capita consumption of small meals was 1.4 kg/month, rural areas consumed 2.2 kg/month. About forty percent of urban households ate millets to control their blood sugar, twenty percent to manage their obesity problem, and twenty seven percent to stay healthy. Just 20% of households in rural areas used millets to treat their diabetes, while the majority of households (57%) used them as a food habit. Experts in food and nutrition motivated about 30% of households in urban areas and 17% of households in rural areas. Melas affected roughly 37% of households in urban areas and 23% of households in rural areas respectively. Ayurvedic clinics and urban advertisements play a significant role in raising awareness of the health and nutritional advantages of consuming small millets (13%).

**Nutritional importance:** "Millets are important staples to millions of people worldwide. Generally, these are rain fed crops grown in areas with low rainfall and thus resume greater importance for sustained Agriculture and food security. Almost all the millets are used for humans consumption in most of the developing countries but their use has been primarily restricted in animal feed in developed countries. Millets are nutritionally comparable to major cereals and serve as good source of protein, micronutrients and phytochemicals. Processing methods like soaking, malting, decortication, and cooking affect the anti-oxidant content and activity" [1].

### **Nutritional composition of millet grains:**

"Millets are unique among the cereals because of their richness in calcium, dietary fibre, polyphenols and protein" [4]. "Table 1 represent amino acids content in different types of millets. Millets generally contain significant amounts of essential amino acids particularly the sulphur containing amino acids (methionine and cysteine); they are also higher in fat content than maize, rice, and sorghum" [5]. "In general, cereal proteins including millets are limited in lysine and

**Table 1. Socio-economic characteristics of sample households in the study area**

Particulars	Urban (n=30)	Rural (n=30)
<b>I. Age group</b>		
a. Below 35years	8(26.67)	5(16.67)
b. 35-50 years	10(33.33)	14(46.67)
c. Above 50years	12(40.00)	11(36.67)
Weighted Average age (Yrs.)	43	46
<b>II. Education</b>		
a. Illiterates	5(16.67)	9(30.00)
b. Primary	7(23.33)	13(43.33)
c. High school	7(23.33)	5(16.67)
d. College	11(36.67)	3(10.00)
<b>III. Average family size</b>	4.00	5.00
<b>IV. Average annual income(Rs./Annum)</b>		
a. <30,000	5(16.67)	11(36.67)
b. 30,000-50,000	4(13.33)	14(46.67)
c. 50,000-1,00,000	9(30.00)	3(10.00)
d. >1,00,000	12(40.00)	2(6.67)

**Table 2. Details of small millets consumption in the study area**

Particulars	Urban (n=30)	Rural (n=30)
Monthly consumption of small millets (kg/month/household)	5.42	11.04
Per capita consumption of small millets(kg/capita/month)	1.4	2.2
<b>III. Reasons for preferring to consume small millets</b>		
a. Diabetes	12(40.00)	6(20.00)
b. Obesity	6(20.00)	2(6.66)
c. To stay healthy	8(26.67)	5(16.67)
d. Food habit	4(13.33)	17(56.67)
<b>IV. Motivation for consumption of small millets</b>		
a. Food and Nutritional Experts	9(30.00)	5(16.67)
b. Ayurveda clinics	4(13.33)	0.00
c. Friends and relatives	3(10.00)	13(43.33)
d. Television and News paper	3(10.00)	5(16.67)
e. Millets and Organic melas	11(36.67)	7(23.33)

**Table 3. Nutrition Composition of millets per 100g of edible portion**

Food grains	Proteins (g)	CHP (g)	Fat (g)	Crude fiber (g)	Mineral matter (g)	Ca (mg)	P (mg)	Iron (mg)
<b>Millets</b>								
Finger millet	7.3	72.0	1.3	3.6	2.7	344	283	3.9
Kodo millet	8.3	65.0	1.4	9.0	2.6	27	188	12.0
Proso millet	12.5	70.4	3.1	7.2	1.9	14	206	10.0
Foxtail millet	12.3	60.9	4.3	8.0	3.3	31	290	5.0
Little millet	7.7	67.0	4.7	7.6	1.5	17	220	6.0
Barnyard millet	6.2	65.5	2.2	9.8	4.4	11	280	15.0
<b>Cereals</b>								
Rice	11.8	71.2	1.5	1.2	1.5	41	306	5.3
Wheat	6.8	78.2	0.5	0.2	0.6	45	160	-

**Table 4. Vitamins and Mineral composition of millet mg per 100 g of edible portion**

Parameter	Finger	Proso	Foxtail	Little	Kodo	Barnyard	Pearl	Sorghum
Total Carotenoids	154	-	32	120	272	-	293	212
Thiamine	0.37	0.20	0.59	0.26	0.29	0.33	0.33	0.35
Riboflavin	0.17	0.18	0.11	0.05	0.20	0.10	0.25	0.14
Niacin	1.34	0.18	3.20	1.29	1.49	4.20	2.30	2.10
<b>Minerals</b>								
Calcium	364	14	31	16.06	15.27	20	42	27.6
Phosphorus	283	206	290	220	188	280	296	274
Iron	4.62	0.8	2.8	1.26	2.34	5.0	8.0	3.95
Magnesium	137	153	81	133	147	82	137	1.33
Sodium	11	8.2	4.6	8.1	4.6	-	10.9	5.42
Potassium	408	113	25	129	144	-	307	328
Copper	0.67	1.60	1.40	0.34	0.26	0.60	1.06	0.45
Zinc	2.3	1.4	2.4	3.7	0.7	0.3	3.1	1.96

**Table 5. Proximate composition of millet grain varieties**

Component (g/100g dry basis)	Foxtail millet flour	Fonio whole grain	Proso millet dehulled grain	Pearl millet whole grain	Finger millet native grain
Protein	11.50	9–11	11.58	14.8	8.2
Ash	0.47	1–1.1	NA	1.64	2.7
Fat	2.38	3.3–3.8	4.9	4.86	1.8
Total CHO*	75.2	84–86	80.1	59.8	83.3
Crude fiber	NA	NA	0.7	12.19	3.5

Carbohydrate (CHO) NA: Not available

**Table 6. Households perception on health benefits of small millets consumption**

Sl. No.	Health benefits	Urban households (n=30)		Rural households (n=30)	
		Number	Percentage	Number	Percentage
1	Control of diabetes	20	66.67	66	20.00
2	Weight loss	15	50.00	9	30.00
3	Control of gastric problems	13	43.34	15	50.00
4	Facilitate digestion	18	60.00	12	40.00
5	Agile	19	63.34	24	80.00
6	Other health benefits (Hypertension, heart problems etc.,)	10	33.34	8	26.67
7	No change	10	33.34	17	56.67

**Table 7. Properties of Dietary fiber and their health consequences**

Function	Health Consequences	Millet
Water absorbing and bulking property	Energy diluents to formulate low calories diet	All Millets
Increased transit time of food in gut	Reduced risk of inflammatory bowel disease	Sorghum and finger millet
Bile acid and steroid binding	Hyper cholesterolemia activity and reducing the risk of cardiovascular disease	Pearl millet, Sorghum and finger millet.
Retardation of carbohydrate	Management of certain type of	Pearl millet, Sorghum and
Binding of toxins	As a detoxifying agent	Sorghum
Binding of divalent cations	Reduced bioavailability of Ca, Mg, Zn, Fe	Proso Millet and Fox Tail Millet (Unprocessed)

**Table 8. Nutritive value of Indian food items per 100 g of consumption**

<b>Food items</b>	<b>Energy (kc)</b>	<b>Protein (g)</b>	<b>Fat (g)</b>	<b>Calcium (mg)</b>	<b>Iron (mg)</b>	<b>Thiamine (mg)</b>	<b>Riboflavin (mg)</b>	<b>Niacin (mg)</b>	<b>Vitamin C(mg)</b>	<b>Carotene(µg)</b>
Rice	345	6.80	0.50	10.00	0.70	0.06	0.06	1.90	0.00	0.00
Ragi	328	7.30	1.30	344.00	3.90	0.42	0.19	1.10	0.00	42.00
Wheat	341	12.10	1.70	48.00	4.90	0.49	0.17	4.30	0.00	29.00
Turdal	335	22.30	1.70	73.00	2.70	0.45	0.19	2.90	0.00	132.00
Grams	372	20.80	5.60	56.00	5.30	0.48	0.18	2.40	1.00	129.00
Onion	59	1.80	0.10	40.00	1.20	0.08	0.02	0.50	2.00	15.00
Tomato	20	0.90	0.20	48.00	0.64	0.12	0.06	0.40	27.00	351.00
Potato	97	1.60	0.10	10.00	0.48	0.10	0.01	0.20	17.00	24.00
Beans	158	7.40	1.00	5.00	2.60	0.34	0.19	0.00	27.00	34.00
GLV	45	4.00	0.05	397.00	3.49	0.03	0.30	1.20	99.00	5520.0
OV	24	1.40	0.30	18.00	0.38	0.04	0.11	0.90	12.00	74.00
Fruits	116	1.20	0.30	17.00	0.36	0.05	0.08	0.05	7.00	78.00
Oil	900	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	750.00
Groundnut	561	25.30	40.10	90.00	2.50	0.90	0.13	19.90	0.00	37.00
Coconut	444	4.50	41.60	10.00	1.70	0.05	0.10	0.80	0.10	0.00
Sugar	398	0.10	0.00	12.00	0.16	0.00	0.00	0.00	0.00	0.00
Milk	67	3.20	4.10	120.00	0.20	0.05	0.19	0.10	2.00	53.00
Egg	173	13.30	13.30	60.00	2.10	0.10	0.40	0.10	0.00	420.00
Meat	109	25.90	0.60	25.00	0.00	0.00	0.14	0.00	0.00	0.00
Bajra	361	10.96	5.43	42.00	8.00	0.25	0.20	0.86	0.00	0.00
Sorghum	336	9.97	1.73	25.00	4.10	0.35	0.14	2.10	0.00	0.00
Little millet	348	10.13	3.89	17.00	9.30	0.26	0.05	1.29	0.00	0.00
Kodo millet	333	8.92	2.55	15.27	0.70	0.29	0.20	1.49	0.00	0.00
Foxtail millet	331	12.30	4.30	31.00	2.80	0.59	0.11	3.20	0.00	0.00
Barnyard millet	307	6.20	2.20	20.00	5.00	0.33	0.10	4.20	0.00	0.00
Proso millet	341	12.50	1.10	14.00	0.80	0.41	0.28	4.50	0.00	0.00
Browntop millet#	338	8.89	1.89	28.00	7.72	0.00	0.00	0.00	0.00	0.00

Note: GLV- Green Leafy Vegetables, OV: Other Vegetables

Source: Gopalan et al., 2007 and Nutritive value of Indian foods, NIN – 2007, # Roopa, 2015

tryptophan content and vary with cultivar. However, most cereals contain the essential amino acids as well as vitamins and minerals" [4,6]. "Plant nutrients are largely used in the food industry, and cereal grains constitute a major source of dietary nutrients worldwide" [1] (Izadi et al., 2012). "Modification of a protein is usually realized by physical, chemical, biological such as fermentation or an enzymatic treatment, which changes its structure and consequently its physicochemical and functional properties" [7,1,8-10].

#### Policy Recommendations:

1. **Research and Development:** Increased investment in research to improve millet varieties, focusing on yield, pest resistance, and nutritional content.
2. **Awareness Campaigns:** Education programs to raise awareness about the health benefits of millets and encourage their consumption.
3. **Market Access:** Support for smallholder farmers to access markets, improving their economic standing and incentivizing millet cultivation.

#### 4. CONCLUSION

Millets present a multifaceted solution to the challenges of food and nutritional security in developing countries. By promoting their cultivation and consumption, we can enhance resilience to climate change, improve health outcomes, and empower local communities. Sustainable practices centered around millet can contribute significantly to achieving food security and improving the livelihoods of millions. Combination of millets with other sources of protein would compensate the deficiency of certain amino acids such as lysine. Successful improvement of these attributes would be a crucial key to expand the spectrum of applications of millet grains. Future trends should focus on the millet consumption in the developed countries that could help its industrial revolution.

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1. CHATGPT
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#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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