KLE Society's

S. NIJALINGAPPA COLLEGE

II[nd] Block, Rajajinagar, Bengaluru - 560 010.

Re-accredited by NAAC at 'A+' grade with 3.53 CGPA

College with UGC STRIDE Component – I

PROCEEDINGS

OF

NATIONAL LEVEL SEMINAR ON

"CONTRIBUTION OF MILLETS TO HUMAN HEALTH & WEALTH"

27[th] FEBRUARY 2023

ISBN: 9789358913323

Organized by

DEPARTMENT OF BOTANY

K.L.E SOCIETY'S
S. NIJALINGAPPA COLLEGE
RAJAJINAGAR, BENGALURU- 560010

PROCEEDINGS

OF

NATIONAL LEVEL SEMINAR ON

"CONTRIBUTION OF MILLETS TO HUMAN HEALTH & WEALTH"

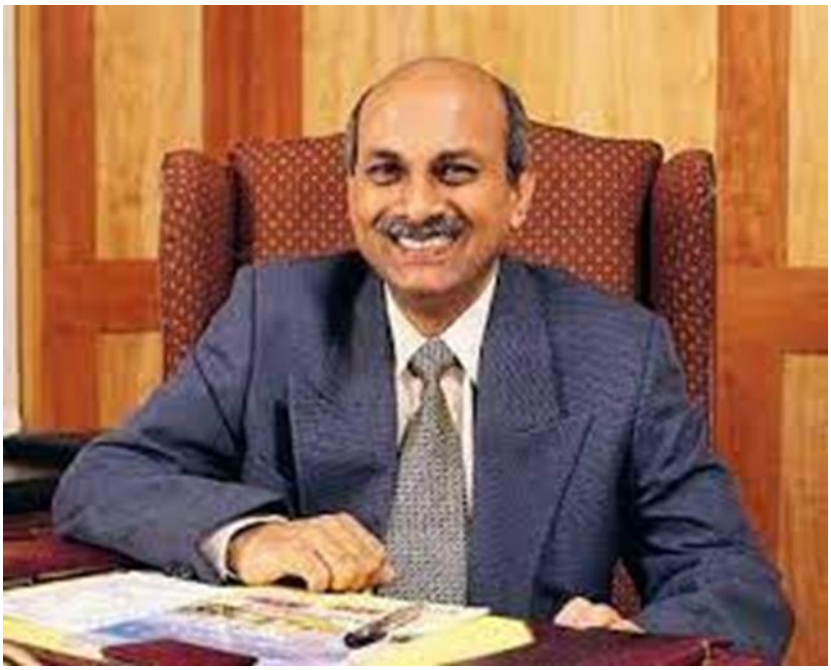
27th FEBRUARY 2023

Organized by

DEPARTMENT OF BOTANY

ISBN: 9789358913323

Chairman's Message



As the KLE Society stands on the threshold of a century of service, I look back with joy at the extent of all that has been achieved. I am humbled too, for I am the torch-bearer of an illustrious tradition of knowledge dissemination that has made a positive difference to the lives of countless thousands.

Every great event, it has been well said, brings one absolute new thing into the world. Such an event was the starting of the K.L.E. Society in 1916 by seven dedicated teachers and three generous patrons. Their mission was to provide education basically, to the children of the farming community who constitute a significant majority in Karnataka. Though modest and unadvertised was their act, yet it created a sensation in the education history in this region.

The KLE Society began in a humble way with the establishment of a single institution in the educationally backward North Karnataka. Over the years, it has grown into a virtual knowledge movement and presently encompasses as many as 250 institutions, 16,000 employees, around 1,25,000 students and KLE Health University. A new chapter now dawned at the KLE Society with the launch of the KLE Technological University (Under Karnataka University Act, 2013) in its fold. Each of these institutions, like the honey bee, sources knowledge from far and wide and converts it into refined educational curricula that benefits knowledge seekers.

In the functioning of the KLE society, the true spirit of democracy runs. The management of the society is effectively carried out by the Chairman of the Board of Management consisting of 15 members duly elected as per the constitutional provisions of the society. The president and vice

president guide the Chairman while the Life members frame academic guidelines. The financial transparency is maintained through regular audit system.

In the process, it brings about change & progress among the individuals, in the community and the society at large to make a world of difference! What the KLE Society is today is the result of the cumulative efforts and selfless striving of many, over the decades. But it was the spark lit by the founders- and the visionaries around them – that enabled all that followed as a beacon of hope that lights up the educational landscape.

Apart from quality educational institutions, health care institutions and other community support programmes, the K.L.E society has earned its recognition outside the boundaries of India. It has entered into collaboration with universities abroad in the USA, UK and Malaysia. This has added to the rich heritage of the K.L.E. Society.

Being at the helm, at this proud moment in the KLE Society's history, I continue to draw inspiration from the original spark, in the commitment to spread the light even further.

Dr. Prabhakar B. Kore
Chairman, K.L.E. Society

Principal's Message

A hearty welcome to KLE Society's S. Nijalingappa College. College is permanently affiliated to Bengaluru City university, Bengaluru. Our esteemed institution with an assurance that we shall together transform the younger generation to a knowledgeable, employable and civilized human resource. It is the prestigious institute of Collegiate Education established in 1963 by globally reputed KLE Society, Belagavi, which has celebrated its centenary during the year 2016. KLE Society was founded by seven selfless dedicated teachers who are known as 'Saparishis'. We have completed more than 60 years of rewarding service in the field of higher education. Today the society is catering the education in all the areas of the school, pre-university colleges, collegiate education, law, health care & sciences, management studies, agriculture, and technical education in Karnataka, Maharashtra, Goa, and Delhi. Under the leadership of Dr. Prabhakar B. Kore, MP the Society has seen exponential growth and has achieved the distinction of having been conferred the status of "deemed-to-be university" in the areas of medical education and technical education.

Our institution offers a wide variety of conventional and need based courses on Arts, Commerce, Science and technical fields in keeping with the globalised scenario.

Department of Botany established in the year 1967 has been striving hard to impart a rich knowledge of plant sciences to the students. It is making constant efforts to bring together academicians. Scientists, Ayush practitioners, researchers and students to share, discuss and disseminate information in the field of plant sciences and real-world challenges encountered. The department has been regularly conducting conferences, workshops and seminars in different fields related to plant sciences to achieve its objective. Since its inception it is striving hard to impart the knowledge

of Botany at U.G. Level. The faculty has contributed a lot to the growth of the department. Three MRPs are successfully completed and conducted many UGC sponsored and Management funded Seminars and Workshops.

The seminar mainly focuses on Millets and its nutritional benefits which has become an indispensable part of our life. Immense nutritional and health benefits of millets and their suitability to grow in adverse climatic conditions has inspired us to conduct this event. The importance of nutrition as a foundation for healthy development has been drawing greater attention of researchers, academicians and environmental scientists. This seminar is an attempt to bring together the scientists, research scholars, academicians and students all over the state on a single platform to disseminate the nutritional importance of millets. I hope this seminar will help the delegates to enhance their knowledge about millets and fulfil the objectives.

Dr Arunkumar B. Sonappanavar
Principal, KLESNC

ABOUT THE COLLEGE

K.L.E. Society's S. Nijalingappa College, established in the year 1963, is one of the premier educational institutions of K.L.E Society. It made a humble beginning in a rented building on Mahatma Gandhi Road, near Mayo Hall, as a Science College. It was shifted to the present premises in 1966. The founder Principal Dr. V.G. Nelivigi laid a firm foundation for the college and was responsible for development of the college, by its inclusion under 2(f) and 12(B) of UGC.

The college initially offered underground programmes in basic sciences, Arts, and Commerce. It has grown from strength to strength fortifying itself at every step to stimulate the increasing academic needs of the students. Need based programmes in electronics and computer science were introduced in 1980s. Business Management and Computer Applications were introduced in 1990s. With the advent of the twenty first century undergraduate programmes in Biotechnology, Fashion and Apparel Design, Journalism and Post graduate programmes in Computer Applications, Commerce, Masters in Tourism and Administration (MTA) and 5-year integrated PG course for MTA from 2007 were introduced. The college has an aesthetic aura with the campus area of 4.95 acres which instils an educative spirit in the seclusion of its surroundings; the lush green gardens provide a serene atmosphere. The college emphasizes the importance of the knowledge gained in the classes to its logical verification in its well-equipped and spacious laboratories. Holistic personality development is ensured through the counselling centres, placement cell, advanced development is ensured through the counselling centers, Placement cell, advanced library facilities, Internet centers and multispeciality Gymnasium. The health center caters to the health care for its wards. Hostels with transport facilities are provided. The college takes pride on its distinguished alumni in all walks of life. The institution has sustainable practices in various teaching learning methods viz lecture method, interactive method, project-based method, seminar method, field study and others.

Dr. Arunkumar B. Sonappanavar
Principal, KLESNC

ABOUT THE SEMINAR

The world is celebrating this year 2023 as International year of Millets as declared by united general assembly which was proposed by our prime minister Sri Narendra Modiji. Department of Botany takes it as a privilege to be a part of this celebration and raise awareness about significance of millets. In this context we are organising one day National level seminar on millets. Immense nutritional and health benefits of millets and their suitability to grow in adverse climatic conditions have inspired us to conduct this event. The importance of nutrition as a foundation for healthy development has been drawing greater attention of researchers, academicians and environmental scientists. This seminar is an attempt to bring together the scientists, research scholars, academicians and students all over the state on a single platform to disseminate the nutritional importance of millets. The current seminar will help the delegates to enhance their knowledge about nutritional importance and research findings on millets.

Objectives

- The seminar was aimed at initiating discussions and formulating strategies towards adopting millet as the means of transformation to impart sustainable development and promotion of natural farming practices.
- To evolve high yielding varieties in small millets.
- To produce and distribute quality seeds in small millets.
- To popularize micro irrigation, organic farming and fertigation in small millets among the farmers.
- To popularize mechanization in small millets to mitigate labour scarcity.
- To popularize mechanization in small millets to mitigate labour scarcity.
- To gives us the precise description on the millet usage.
- To emphasize the role of millets in human health and to contribute sustainable Agriculture by the multi crop agricultural system.
- Students and faculty will be enriched by the knowledge about importance of consumption of millets.

NATIONAL LEVEL SEMINAR ON

"CONTRIBUTION OF MILLETS TO HUMAN HEALTH & WEALTH"

Organizing Committee

President	:	**Dr. Arunkumar B. Sonappanavar**
Convenor	:	**Mrs. Roopashree M G**
Organizing Secretary	:	**Dr. Banani Misra**
Joint Secretaries	:	**Mrs. Yashodha M . Yadahalli**
		Mrs. Jamuna K

ADVISORY COMMITEE

Dr. Arunkumar B. Sonappanavar

Principal, President, Organizing Committee

Sri. Rajaiah B.

HOD of Chemistry and Convenor of Science Forum.

Dr. Rajkumar Badiger

HOD of Physics

Prof. Chandrashekarappa A. S.

IQAC Co-ordinator & HoD, Mathematics.

Dr. Tejaswini V. Nandi

HOD of Zoology, Convenor, YRC

NATIONAL LEVEL SEMINAR ON

"CONTRIBUTION OF MILLETS TO HUMAN HEALTH & WEALTH"

PROGRAMME SCHEDUL

INAUGURAL SESSION

10 AM	:	**Invocation by Shalini, II BSc BZ**
10:15- 10:30AM	:	**Welcome speech by Dr. Banani Misra** **Assistant Professor, Dept of Botany organizing secretary CMHW**
10-30-10.45	:	**Introduction to Chief Guest** **Roopashree M.G., HOD of Botany and Convenor**
10:30-11:30 AM	:	**Inauguration and Key note address** **Dr. Sukanya T S** **Principal Scientist, PC Unit, AICRP, UAS GKVK Bengaluru**
11.30 AM	:	**Presidential Remarks** **Dr. Arunkumar B. Sonappanavar** **Principal, KLE's S Nijalingappa College**
11.45 AM	:	**Vote of Thanks by Mrs. Jamuna K.**

TEA BREAK

12:00 – 1:00 PM	:	**Technical Session** **Dr. Suresha K.B.** **Associate Professor and Head, Centre of Excellence for Nutricereals, UAS GKVK**

LUNCH BREAK

2:30- 4:00 PM	:	**Paper Presentation Session** **Smt Yashodha yadahalli** **Assistant Professor** **Department of Botany, KLESNC**

VALEDICTORY SESSION

4:00-5.30 PM	**:**	**Mrs Jamuna K.** **Assistant Professor** **Department of Botany, KLESNC**
Presentation of Report	**:**	**Smt. Roopshree M G** **Roopashree M.G., HOD of Botany and Convenor**
Valedictory Addresss	**:**	**Dr. Arunkumar B. Sonappanavar** **Principal, KLE's S Nijalingappa College**
Vote of thanks	**:**	**Ms Likitha M** **II B.Sc BZ**
MOC	**:**	**Mrs. Jamuna K** **Assistant Professor,** **Department of Botany, KLESNC**

CONTENTS

1. MILLETS - A BOON FOR INDIAN AGRICULTURE AND FOR FOOD AND NUTRITIONAL SECURITY

Dr. T. S. Sukanya
Project Coordinating Unit, ICAR-AICRP on Small Millets, GKVK, Bengaluru-560 065, India.
Email: tssukanya@gmail.com

Abstract: Millets are very important plant genetic resources for agriculture sector that extends food security to poor farmers having arid, marginal and poor lands especially in Asia and Africa. Millets are a group of small grain cereal food crops which are highly nutritious and are grown under marginal/low fertile soils with very low inputs such as fertilizers and pesticides. Indian agriculture is highly dependent on monsoon. Millets are also gaining popularity among farmers as climate-friendly, drought-resistant crops which can thrive even on barren soil. These crops are preferable choice of farmers for cultivation under various adverse environments - prone to climatic extremes. Millets are gluten-free and have a low glycemic index, making them a balanced and healthy diet for people suffering from diabetes. An intensive attempt to include millet crops in cropping systems, especially in vulnerable environments, is a positive step towards long-term sustainability. An effort has been made to expand global and regional scope and target for millet production, usage, and in this regard, India's proposal to observe an International Year of Millets in 2023 was approved by the Food and Agriculture Organization (FAO) during 2018 and the United Nations General Assembly has declared the year 2023 as the International Year of Millets. In this esteem, the status of millets and their importance is compiled in this paper.

Key words: Millets, Nutricereals, Nutrition, Area, Production, Cultivation, Duration, Marketing

---

Nutri-cereals are grown in arid and semi-arid tracts under low rainfall (300-600 mm) conditions, where cereals like wheat and rice cannot be grown profitably. Millets are being referred as Nutri-cereals are important crops in the country with higher area coverage as compared to wheat and rice before green revolution period. After launching green revolution, the area of nutri-cereals drastically reduced due to shifting of irrigated area from nutri-cereals to more remunerative crops like rice, wheat and sugarcane. At present, Nutri-cereals are grown in resource poor agro-climatic regions, hilly & tribal areas of the country in rainfed conditions. The millets role can never be overlooked for attaining justifiable means for nutritional safety (Kumar *et al*., 2018). The abiotic stresses such as drought, salinity and nutrient deficiencies (N, P, K, B, and Zn) seems to have lesser impact on the performance of finger millet (Maharajan *et al*., 2018; Ramakrishnan *et al*., 2017;Yamunarani *et al*., 2016). Millets are grown from mean sea level to 2300 m above mean sea level showing their ability under diverse soil and climatic conditions. However, these ignored crops are important by

ISBN: 9789358913323

virtue of their role in biodiversity and the means of livelihood of the poor in various parts of the world (Belton & Taylor, 2004). In India, they are seen from Tamil Nadu in the south to Uttarakhand in the North and Gujarat in the West to Arunachal Pradesh in the Northeast (Sukanya *et al*., 2022). Millets are a group of relatively small cereal grasses that are classed as major millets or minor millets based on grain size. Millets have excellent nutritional value and grow well under diverse situations, but they aren't utilized to their full potential. Sorghum and pearl millet are regarded as major millets while, finger millet, foxtail millet, kodo millet, proso millet, barnyard millet, little millet and browntop millet are named as minor millets. Millets are richer in minerals and vitamins than rice and wheat, and have a significant potential to supply food, nutrition, fodder, fiber, health, livelihood, and environmental security. Millets have been the first cereal grain to be cultivated for domestic use. Millets are hardy and grow well in rain-fed situation under marginal soil fertility and low moisture. Millets are versatile, climate-resilient crops and can be grown under diverse soil and climatic situations. India is the world's largest producer of millets. In India, millets are cultivated over a total area of 35.71 million hectares, yielding 62.49 million tonnes in 2020(Anon., 2020). They are significant in densely populated countries like India and millets can be kept in good condition for many years and hence they are called as famine reserves. Millets are also being used in the animal feed industry and distilleries.

Millets in World

India is one of the important consumers and producers of Nutri-cereals in the world. Group of crops comprising sorghum (Jowar), pearl millet (Bajra) and small millets viz., finger millet (Ragi/Mandua), little millet (Kutki), kodo millet (Kodo), barnyard millet (Sawa/Jhangora), foxtail millet (Kangni/Kakun), proso millet (Cheena), browntop millet (Makra/murath) all together comes under Millets which are now called as 'Nutri-Cereals' due to their higher nutritive value. The spatial distribution of millets either as a primary crop or as allied crops, is generally determined by the growing habitat and the amount of rainfall received in the region. Small millets are produced in 31.01 million tonnes around the world, according to the FAO, from an area of 33.56 million hectares (Anon.,2018). The most common millet crops are sorghum and pearl millet, which account for more than 90 per cent of global millets production, followed by finger millet. foxtail millet, proso millet, barnyard, little millet, kodo millet and browntop millet which account for less than 10 per cent of all millets (Anon., 2020a). In terms of productivity, foxtail millet outstands all the other millets by accounting 2166 kg/ha followed by finger millet (1623

kg ha^{-1}), proso millet (1535 kg ha-1), sorghum (1426 kg ha^{-1}), barnyard millet (1034 kg ha^{-1}), pearl millet (850 kg ha^{-1}) and little millet (469 kg ha^{-1}) (Assocham, 2021).

ISBN: 9789358913323

Millets in India

India is the world's largest producer of millets. Millets are grown in almost 21 states across the country. Maharashtra, Karnataka and Rajasthan in Jowar; Rajasthan, Uttar Pradesh and Gujarat in Pearl millet; Karnataka, Uttarakhand and Maharashtra in Finger millet; Madhya Pradesh, Chhattisgarh and Uttarakhand in other small millets are three major states where these nutricereals are grown and the area is showing declining trend from previous years although the productivity is towards promising inclination (Anon., 2020). In India, Finger millet and other small millets are cultivated in an area of 10.48 and 5.45 lakh hectares (2016-20) with a production of 16.37 and 3.95 lakh tonnes, respectively. In spite of drastic decline in the area in the last six decades, the total production is maintained same to some extent due to the enhanced productivity of millets over the years.

Millets for Nutritional Benefits

Millets are vital in Africa, Asia, China and are extremely nutritious, and in some ways, they outperform rice and wheat in terms of presence of key nutrients like phosphorus, potassium, magnesium, manganese, iron and niacin. Protein, fibre, important amino acid like methionine, lecithin, and vitamin E are also found in them. Millets have a low glycemic index, suiting them ideal for diabetics (Dayakar Rao *et al*., 2017). The calcium content of finger millet is nearly ten times that of rice or wheat, and proso millet contains about 12 % protein. Every millet is far superior to rice and wheat in terms of nutrients and so is the answer to the malnutrition that is affecting bulk of the Indian population. Small seeded grains are produced by these grasses, which are commonly used as cereals. Millets are being demonstrated in recent exploration to provide therapeutic effects, such as controlling asthma, migraine, blood pressure, diabetic heart disease, atherosclerosis, and heart attacks, due to their high level of these nutrients. Gallstones are prevented by the fibre in millet. Whole grains of millets, contain health-promoting properties comparable to, if not superior to, fruits. To overcome malnutrition, systematic eating can help to solve the major issue which is prevalent in our Indian population. Millets provide more calcium, iron, beta-carotene, and other nutrients than rice and wheat. Jowar has eight times the fibre of rice, ragi has forty times the calcium of rice, and bajra has eight times the iron and five times the riboflavin and folic acid of rice

Millets – Benefits in Cultivation

The agronomic practices are critical for accomplishing an assured harvest (Hegde and Krishne Gowda, 2003). Millets are probably the best alternative for farmers who would like to achieve the triple objectives of farming versatility, sustainability, and profitability. The advantages of millets-

ISBN: 9789358913323

based farming techniques are many as millets are awfully resistant to harsh temperatures, drought, and floods. Millets can be grown successfully in dry zones/rain-fed locations with limited soil fertility and moisture. Because of their excellent root system, water requirement of these crops is less in comparison to other crops and have climate resilient traits. Millets need lesser moisture for production and cultivated under rainfed situations or under regimes of lesser rainfall (200-500 mm). The storage life of grains is relatively long (two years or beyond). Millets growing is a low-cost practice. The majority of the added ingredients are organic and respond very well to integrated nutrient management practices (Basavaraja Patil *et al*. (2022), Deepti *et al*. (2022) and Kumar *et al*., 2003). Millets have a higher number of tillers than other crops. They serve as both food and forage for the animals.

These millets have agronomic advantages *viz*., highly adapted to low rainfall conditions, able to withstand fairly long dry spells, recover fast after delayed rain, make them good contingent crops. Millets are highly resilient in adapting to different ecological conditions; ideal crops for climate change and contingency planting. Being C4 plants these are more environment friendly with high water use efficiency and low input requirement, but equally responsive to high input management

Millets-Ecofriendly crop

These have lower requirement of water, chemicals and management interventions for raising. Besides, millets can come up in marginal lands and harsh weather conditions where no other crop can be grown. In India, finger millet farmers realize good yields even with reduced rains and minimum inputs. As these crops are resilient to climate change and provide yield assurance despite environmental risks, they have sustained the onslaught of rice and wheat all these years, despite drastic reduction in cultivation. Another important byproduct of millet cultivation is fodder which is a main source of roughage for cattle in dryland ecosystem. In times of climate change millets are often the last crop standing and thus, are a good risk management strategy for resource-poor marginal farmers. Relatively these crops are less affected by pests and this is a characteristic that comes in very handy when planning a mixed crop cultivated using non-

pesticide management techniques. A few rows of millets separating rows of more susceptible leguminous crops are a common practice in farms in different parts of the world.

Cultivation of Millets

The millets are often rain-fed crops grown in dryland farming conditions even though they respond well to irrigation. Because they grow well in warm weather and are dependent on rain, cropping is

ISBN: 9789358913323

often associated with summer moisture systems like the South Asian monsoons. Fertilizers will increase yield, yet this is often not practiced (Deepthi *et al*., 2022). Field pests and diseases are not of much concern when compared to other cereal crops but there is a need for weeding. Yet grain yield can be significant with minimal energy relative to more traditional crops. Maximum millet cultivation happens in the *kharif* period, *i.e*., during the monsoon season. In areas that receive more than 800 mm of rains, many of the millets can be cultivated in the second season, *i.e.*, as a *rabi* crop (during the post monsoon, early winter months). And in some places with the right soil and geography, a few millets can even be grown in the third season, during the dark days of winter, utilizing residual moisture in the soil and the dew that precipitates (Sukanya *et al.,* 2022).

Constraints in Millet Production

Low productivity of millets, non-availability of good quality seeds, lesser shelf life of millet value-added products, lack of technologies and machinery for primary and secondary processing, dearth of continued demand, lack of awareness on the nutritive value of millets, lesser established market linkages, and lack of uniform standards and grades for exporting are the major problems. Beside its numerous advantages, there are a few drawbacks in millet production that must be addressed. Further, the expansion of area under millets in non-traditional millet cultivating markets, more value-added products, lack of more ready to cook products are also the issues to be addressed.

Table 1 The climate resilient traits of Small millets

Crop	Duration (days)	Climate resilient traits
Finger millet	90-130	Adapted to wide altitude range, moderately resistant to drought, heat stress and humidity
Foxtail millet	70-120	Adapted to high altitude and low rainfall conditions
Proso millet	60-90	Short duration crops, adapted to high altitude and low rainfall conditions
Little millet	70-110	Famine food, adapted to poor soils, low rainfall and can also withstand water logging to some extent
Kodo millet	100-140	Very hard crop with long duration, adapted to low rainfall, poor soils and shows good response to improved agronomic practices
Barnyard millet	75-90	Short duration crop, well adapted to high altitudes and low rainfall conditions.

ISBN: 9789358913323

Table 2: The yield potential of small millets under optimum management practices

Small millet	Harvesting and Yield
Finger millet (*Eleusine coracana* L.)	25-35 q/ha of grain and 60-70 q/ha of fodder.
Foxtail millet (*Setaria italica* L.)	20-25 q/ha of grain and 30-40 q/ha of straw is expected.
Little millet (*Panicum sumatrense* L.)	18 - 20 q/ha of grain and 25-30 q/ha of straw is expected under well managed agronomic practices.
Proso millet *(Panicum miliaceum L.)*	Crop comes to harvest in 65 - 80 days of sowing in most of the varieties. Harvesting is to be done at physiological maturity and with the adoption of improved package of practices, it is possible to harvest 18-20 q/ha grain and 25-30 q/ha straw under rainfed situation. Under irrigated situation,20-25 q/ha grain and 50-60 q/ha straw is expected.
Kodo Millet (*Paspalum scrobiculatum* L.)	With the adoption of package of practices, kodo millet can yield upto 20- 25 q/ha grain and 30 – 40 q/ha straw.
Barnyard millet (*Echinochloa frumentacea* L.)	The crop should be harvested when it attains the physiological maturity. Generally, it is cut from the ground level with the help of sickles and stacked in the field for about a week before threshing is done by trampling under the feet of bullocks. 15-20 q/ha grain and 25-30 q/ha can be realized by following the improved production practices.
Browntop millet (*Brachiaria ramosa* L.)	The crop should be harvested as soon as it attains the physiological maturity. 15-20 q/ha grain and 20-25 q/ha straw can be harvested by following the improved production practices.

REFERENCES

1. ANONYMOUS, 2018, Food *and Agriculture Organization* (FAO). (ONI11407).
2. ANONYMOUS,2020, Agriculture Statistics at a Glance, *Ministry of Agriculture and Farmers Welfare*, Department of Agriculture, Cooperation and Farmers Welfare and Directorate of Economics and statistics.
3. ANONYMOUS, 2020a, *Indian Institute of Millet Research*, Hyderabad. Bulletin. www.iimr.com
4. ASSOCHAM, 2021, A Knowledge paper on Millets-*Status & Way Forward, An outcome of Virtual Meeting* (July 9, 2021) organized by ASSOCHAM.
5. BASAVARAJA PATIL, N. UMASHANKAR, T.S. SUKANYA, A. SATHISH AND S. TULJA, 2022, Evaluation of Liquid Biofertilizer on Growth and Yield of Finger millet (*Eleusine coracana*). *Mysore J. Agric. Sci.*, **56**(3):63-73.
6. BELTON, P. S. AND TAYLOR, J. R. N., 2004, Sorghum and millets: Protein sources for Africa. *Trends Food Sci. Technol.***15**(2): 94–98.

ISBN: 9789358913323

7. DAYAKAR RAO, B., BHASKAR ACHARY, K., ARLENE CHRISTINA, G.D., SUDHA DEVI, G. AND VILAS A. TONAPI, 2017, Nutritional and Health benefits of Millets. ICAR_Indian Institute of Millets Research (IIMR) Rajendranagar, Hyderabad, PP 112.
8. DEEPTHI, C.H., SUKANYA, T. S., LATHA, H. S., UMASHANKAR, N., ANAND, M. R. AND MAMATHA, B., 2022, Response of Finger Millet (*Eleusine coracana* L.) to Liquid Biofertilizer Consortium and its Methods of Application. *Mysore J. Agric. Sci.*,**56**(1):65-71.
9. HEGDE, B. R. AND KRISHNE GOWDA, K. T., 2003, Sustaining productivity of small millets under rainfed conditions. In. Annual Small Millets workshop, UAS Bengaluru.
10. KUMAR, B.H., SHARAPPA, A., KRISHNE GOWDA, K.T. AND SUDHIR, K., 2003, Growth yield and nutrient uptake as influenced by integrated nutrient management in dryland Finger millet (*Eleusine coracana* L. Gaertn*). Mysore J. Agric. Sci.,* **37**(1):24-28.
11. KUMAR, A., TOMER, V., KAUR, A., KUMAR, V., AND GUPTA, K., 2018, MILLETS: A SOLUTION TO AGRARIAN AND NUTRITIONAL CHALLENGES. *Agriculture & Food Security*, ***7***(1): 31.https://doi.org/10.1186/s40066-018-0183-3
12. MAHARAJAN, T., CEASAR, S. A., AJEESH KRISHNA, T. P., RAMAKRISHNAN, M., DURAIPANDIYAN, V., NAIF ABDULLA, A.-D., AND IGNACIMUTHU, S., 2018, Utilization of molecular markers for improving the phosphorus efficiency in crop plants. *Plant Breed.* **137**:10–26. doi: 10.1111/pbr.12537lanta, **250**: 1433–1448. https://doi.org/10.1007/s00425-019-03237-9
13. RAMAKRISHNAN, M., CEASAR, S. A., VINOD, K., DURAIPANDIYAN, V., KRISHNA, T. A., UPADHYAYA, H. D., 2017, Identification of putative QTLs for seedling stage phosphorus starvation response in finger millet (*Eleusine coracana* L. Gaertn.) by association mapping and cross species synteny analysis. *PLoS One* 12:0183-261. doi: 10.1371/journal.pone.018326
14. SUKANYA, T. S., PRABHAKAR, KRISHNE GOWDA, K. T., SWARNA, R., HARIPRASANNA, K. AND TONAPI, V. A.,2022, G*ood Agronomic Practices for Higher Yield in Small Millets*, ICAR-Indian Institute of Millets Research, Hyderabad, p108.
15. YAMUNARANI, R., GOVIND, G., RAMEGOWDA, V., THAMMEGOWDA, H. V., AND GULIGOWDA, S. A.,2016, Genetic diversity for grain Zn concentration in finger millet genotypes: Potential for improving human Zn nutrition. *Crop J*. **4**:229–234. doi: 10.1016/j.cj.2015.12.001

ISBN: 9789358913323

2. PROCESSING AND VALUE ADDITION FROM NUTRI-CEREALS

Dr. K. B. Suresha & Er. Satishkumar
Centre of Excellence for Nutri-Cereals
University of Agricultural Sciences GKVK. Bengaluru, Karnataka, India
Email:suresha.kb@gmail.com

Introduction

Millets are the sixth most important cereal grains in the world, sustaining more than one-third of the world's population. Millet is the generic name given to more than 6,000 species of small seed wild annual grasses found throughout the world used both as human food and for animal forage. Millet is one of the oldest human foods and believed to be the first domesticated cereal grain. Millet is tiny in size and round in shape and can be white, gray, yellow or red. It is a tiny seed with a nutty flavour, which lends itself well to being cooked and eaten whole.

Millets are high in nutritional value as they contain nutrients including carbohydrates, protein, sugar, soluble and insoluble fiber, sodium, vitamins, minerals, fatty acids, amino acids and more. Majority of millet grains contain higher protein, fibre, calcium and minerals than wheat and rice. Therefore, these are now also being called as **"Nutri-cereals"**. They contain high amount of lecithin, rich in B vitamins, especially niacin, B6 and folic acid. Millets are a good source of the minerals like calcium, iron, potassium, zinc phosphorus, manganese and magnesium. Millets are least allergic and most digestible grain available among all food grains. In addition to the nutrients millets also providemany health benefits.

In this article, an effort is being made cover various aspects of millet processing and utilization of millets in different value-added products.

Processing of Millets: -

Processing of millets is required to make them edible. Millets are small grains with different sizes. The variation in the size and shape of grains makes their processing is difficult. Millets are utilized in various ways in cooking. Creamy like mashed potatoes or fluffy like rice, millet is a delicious grain that can accompany many types of food. Mixture of milk and millet provide all nutrients required to maintain good health among consumers. Hence, millet flour and their forms are added in dairy and other foods to develop value added products. The majority of the world's commercial millet crop is produced by India, China and Nigeria.

Among the millets, ragi is the most easily processed millet. In order to make the millets edible following steps may be adopted. Those are De-husking, Pearling, Hydrothermal Treatment (Parboiling), Milling, Malting, Popping, Cooking etc. De-husking in Centrifugal Sheller followed by debranning in huller yields the grain of satisfactory quality. Pearling is the process followed to polish the de-husked grains to remove the part of husk that is still remaining on the grain after de-husking. Pearling improves the overall appearance of the millet grains and improves the

ISBN: 9789358913323

acceptability of grains. hydrothermal treatment of ragi was done by raising moisture of ragi to approximate 35%, steeping at room temp or < 70°C, steaming at atmospheric pressure for 30min or at 4kg/cm for 6min followed by drying at 40°C has resulted in better quality of parboiled grains which can be used for further value addition. Soaking of different millets in boiling water (100°C) for 10min. & sun drying has resulted in better acceptability of the parboiled grains. However, for better de-husking soaking at 28-30°C/24h, open steaming for 10min followed by sun drying was found to be optimum. There are no exclusive mills for milling the small millets. Hence, de-husking and de-branning of millets is being done in existing cereal milling machinery only with a little modification in the process. Malting of finger millet improves its digestibility, sensory and nutritional quality as well as pronounced effect in lowering the anti-nutrients. It is resistant to fungal infection and elaboration of alpha and beta amylase during germination and during roasting/kilning a desirable aroma as well as is developed which makes it an ideal grain for malt foods. Brewing of millet is practiced to a very limited extent. A traditional brew is prepared by fermentation of finger millet by Tibetans. Kodo and proso millets are also brewed by tribes. Popping is done by agitating the grains in hot sand for a short time. While popping the millets, the husk gets separated but the bran remains adhering to the endosperms. Since bran is rich in oil it can affect the storage quality of the products. Separation of bran from popped grain is very difficult. Popped grains are prepared by using sand as medium and maintaining high temperature. But it is a conventional method often containing sand particles. Like all grains, before cooking millet rinse it thoroughly under running water and then remove any dirt or debristhat you may find. After rinsing, add one part millet to two and a half parts to three boiling water. After the liquid has returned to a boil, turn down the heat, cover and simmer for about 25min. The texture of millet cooked this way will be fluffy like rice.

Cleaning, Grading and De-stoning machines: -

After harvesting, grains needs to be dried to have optimum moisture content to store the grains safely without deterioration. Cleaning, grading and destoning of the millets are very importantaspect of primary processing before the grains are subjected to the dehulling/de-husking to make them free from dirt, dust, stones and unwanted foreign matters.

ISBN: 9789358913323

Cleaning, Grading and de-stoning machines

Cleaning grading and de-stoning of the millets are very important aspect of primary processing before the grains are subjected to dehulling/dehusking to make them free from dirt, stones, dust an unwanted foreign matter. The capacity of Destoner about 200-300 Kg/hr. To operate machine, it requires 3 Phase electrical power with motor capacity 5 hp.

Millet de-husking machines: -

De-husking is must as the millets contain more phytic acid that interferes with digestion. Since long time, due to the unavailability of suitable primary processing, the production and processing of small millets remained constrained. Traditionally, women do this unpleasant, laborious and inefficient hard work. Manually a woman with a pestle and mortar can dehull about 1.5kg/hour providing a non-uniform poor keeping quality kernel.

Millet de-husking machine

Dehulling (removal of husk) millets is a difficult task owing to its small size and husk. Without husk removal, it is impossible to explore the full potential of the grains. The de-husking process results in more loss of grains. De-husking and de-branning in abrasive millets like rice huller damages and breaks the endosperm.

Polishing: -Polishing of millet was done in rice polisher. Degree of polishing was obtained from 3 to 6 min time of milling at an increment of 1 min at 8%, 10%, 12% and 14% of moisture levels. At each moisture level and degree of polishing, proximate compositions (protein, fat, fibre, ash and carbohydrates) were analyzed.

Pearling: Pearling is the process followed the polish the dehusked grains to remove the part of huskthat is still remaining on the grain after dehusking. Pearling improves the overall appearance of the millet grains and improves the acceptability of the grains. Grain Polisher is used for semi polishing millets like Little, Kodo, Foxtail, Proso, Barnyard, Finger, Pearl Millet & Sorghum.

ISBN: 9789358913323

The degree of polished is based on the amount of time the grain is withheld inside the polishing chamber. The AVM industries of salem has developed a polisher. The capacity of the machine 100 Kg per hour, it operates in 3 phase electrical power with 5 hp motor capacity.

Small Millet Polisher

Vibro shifter:

Vibro shifter are circular unitary gyratory screens used to separate mass composition of solids from solids, liquid from solid and for gradation of materials as per particle size, having a very wide range application. Salient Featues: Noiseless, Maintenance free & high speeds. Basically, the Vibro shifter is a vibratiry screening device that vibrates about its center of mass The particles as fine as 400 mesh (37 microns) can be screened, with upto 3 screen decks incorporated in one Vibro separator.

Vibro Shifter

ISBN: 9789358913323

Grain Roaster

Roaster machine is specially manufactured for roasting all kind of Granules, Grains, Seeds, Pulses, Powder & Flour. The capacity of the machine 15 Litre per batch, it operates in single phase electrical power with 2 Kw power consumption with gas connection.

Grain Roaster

Mixer & Blender

Ribbon blender are widely used for homogeneous mixing of dry granules and powders. The blender comprises a "U" tank, shaft with two sets of spiral ribbons, one inside the other. Inner and outer ribbons are perfectly arranged, that during rotation, the material reaches each corner of the trough and imparts radial and linear motion to the whole of the material to be mixed.

Mixer and Blender

Grain Packaging Machine

Grain packaging machine is well known for it's Form fill and Seal machines. It is a automatic cup filler type of packaging speed 15 – 20 pouches per minute. it will pack in any heat sealable Laminated Film pouches.

ISBN: 9789358913323

Grain Packaging Machine

Value added products from millets: -

Proper utilization of small millets which are previously neglected is being promoted as nutri-cereals. By proper processing many different kinds of food products can be made. Milled millet can be further processed to flakes, quick food cereals, ready to eat snacks, supplementary foods, extrusion cooking, malt-based products, weaning foods and more importantly health foods. Kodo millet based popped grain chikki can be prepared by blending 50g of popped grain, 125g of jaggery, 50g of ground nut and 25g gingili. Similarly, proso millet based popped grain chikki can be prepared by blending 50g of popped grain, 100g of jaggery, 25g of ground nut and 25g gingilly. The millet flours at 1% foxtail millet flour for foxtail millet *dahi*, 2% proso millet flour for proso millet *dahi*, 2% barnyard millet flour for barnyard millet *dahi*, and 3 % little millet flour for little millet *dahi* were found to be optimum for millet based *dahi* preparation. Further, when WPC was added at 1 % level to the millet based dahi along with flour at optimized level, the product acceptability was significantly improved.

Millet flours can be successfully incorporated for the development of cold extruded product like vermicelli and for the preparation of vermicelli kheer as they supplement additional good amount of protein and fibre. Raw and parboiled flours could be used up to 40% to prepare millet biscuits, cake and other bakery products in place of maida. For preparing dough nuts maida could be completely replaced with millet flours without affecting the quality of the dough nut and for cookies proso millet flour up to 33% could be recommended and for kodo millet rusk, kodo millet flour canbe used up to 15% replacing maida. The pasta products were developed with the combinations of Finger millet Flour (50 %) + Whole Wheat Flour (40 %) + Defatted Soya Flour (10 %) were adjudgedas the best. Little millet grains are tempered at specific pressure & time. Cooled & rolled. Desired level of sugar & salt are added & extruded through single screw cold extruder & cut into grits. Further, the grits are rolled & solar dried to 5-6% moisture level. Cold extruded products were prepared from all the millets and the formulations were standardized and found that the proso millet pasta masala was preferred most. Hot extruded kurkure type of

ISBN: 9789358913323

products was prepared and the formulations were standardized with barrel temperature of 100-120°C and screw speed of 350- 400 rpm.

Dried flakes are toasted at high temperature in a rotary toaster to obtain the crunchy millet flakes. Diabetes mix was prepared by using clean foxtail millet & split black gram (4:1 ratio) mixed with selected spices in specific combinations are roasted & mixed, & ground into fine powder. For cooking and serving, for each 80g of grain mix, 8 g of spice powder is added & soaked for 30 min, & cooked in 4 times of water to soft consistency and served as hot dish. Developed products reported to have high satiety value, improve life quality, found to reduce blood glucose:14-18
%, and relieves constipation.

Cooking of Millets: -

Like all grains, before cooking millet rinse it thoroughly under running water and then remove any dirt or debris that you may find. After rinsing, add one-part millet to two and a half parts boiling water or broth. After the liquid has returned to a boil, turn down the heat, cover and simmer for about 25min. The texture of millet cooked this way will be fluffy like rice. Cooking time of raw rice was ranged from 4.86 to 6.85min and parboiled rice ranged between 5.01-7.08 min. The swelling ratio of the rice by weight for raw rice was 3.12 to 4.36 and for parboiled rice was 2.99 to 4.27. The swelling ratio by volume for raw rice was 4.17 to 5.26 and for parboiled rice was 4.00 to 5.09. If you want the millet to have a more creamy consistency, stir it frequently adding a little water every now and then. To impart a nuttier flavor to the cooked millet, you could roast the grains first before boiling. To do this, place the grains in a dry skillet over medium heat and stir them frequently. When they have achieved a golden color, add them to the boiling cooking liquid. Cooked millet can be served as a breakfast porridge to which you can add your favourite nuts and fruits. Ground millet can be added to bread and muffin recipes. Toss cooked and chilled millet with your favourite chopped vegetables and either chicken or baked tofu cubes to prepare, delicious meal.

Malting and Brewing:-

Traditionally the millet malt is utilized for infant feeding purpose and also to prepare beverages either with milk of lukewarm water with the addition of sugar since pretty old times. Finger millet has some of the inherent qualities which make it superior compare to other cereals andalso qualify for malting and preparation of malted foods. Finger millet being good malting characteristics, its malting is very popular among growers. Malting of finger millet improves its digestibility, sensory and nutritional quality as well as pronounced effect in lowering the anti- nutrients. It is resistant to fungal infection and elaboration of alpha and beta amylase during germination and

ISBN: 9789358913323

during roasting/kilning a desirable aroma as well as is developed which makes it an ideal grain for malt foods. Brewing of millet is practised to a very limited extent. A traditional brew is prepared by fermentation of finger millet by tibetans. Kodo and proso millets are also brewed by tribals.

Conclusion: -

Millets are still the staple food for millions of poor people in Africa and Asia. Like many other cereals, millets are high carbohydrate energy content and nutritious; making them useful components of dietary and nutritional balance in foods.Proper processing is the need of the hour for creating better avenues for the utilization of millets into many value added products. Value addition may help in development of various millet based dairy foods and other millet-based food products. Consumption of millets can benefit under-nourished children, geriatric population. *Centre of Excellence on Millets* created @ UAS (B) with funding from NFSM, Govt. of India to promote

Processing & value addition of millets. The formulation of millet-based foods helps not only in creating better avenues for the utilization of millets in various millet-based value-added food products but also in health foods. Future trends should focus on the millet consumption in the developed countries that could help its industrial revolution. Increased utilization of millets for consumption can add to the food basket of the world.

ISBN: 9789358913323

3. ROLE OF MILLETS IN INDIAN ECONOMY

Dr. Malini Shetty A. G and Ms Neha R.
Department of Botany, Surana College, S-End Circle, Bangalore-4

INTRODUCTION

Millets are collective group of small seeded annual grasses and belong to the Poaceae family, that are grown as grain crops, primarily on marginal land in dry areas of Temperate, Sub tropical and Tropical regions. Earliest evidence of millets is found in Indus civilization: 3000 BC. Presently millets are grown in 131 countries and is a traditional food for 59 crore people in Asia & Africa. Millets are the only crop that will address important issues in the future like food, feed, fuel, malnutrition and health. Considering climate change effect on present agricultural conditions, millets are more relevant as an agricultural commodity in developing countries with similar geographical conditions.

Millets apart from growing in poor climatic/ soil conditions, providing nutritious grain and fodder, can also fit into multiple cropping systems under irrigation as well as dryland farming due to their short growing season. The prolonged and easy storability of millets under ordinary conditions has given them the status of Famine Reserves and this feature is of great importance for India, as the agriculture of our country suffers from unexpected changes in monsoon.

In India millets are cultivated in low-fertile land, tribal and rain-fed and mountainous areas of our country like states of Haryana, Uttar Pradesh, Chhattisgarh, Gujarat, Rajasthan, Madhya

ISBN: 9789358913323

Pradesh, Maharashtra, Andhra Pradesh, Karnataka, Tamil Nadu and Telangana. Nine types of Millets are grown in India, the major ones are Sorghum, Pearl Millet and Finger Millet covering 95% of the total millet growing area in India and the rest 5% are Little Millet, Foxtail Millet, Barnyard Millet, Proso Millet, Kodo Millet, and Brown top Millet.

Table 1.Global Scenario:

S.No.	Continents	AreaUnder Cultivation	Production
1.	Asia	162 lakh Ha	215 lakh ton
2.	Europe	8 lakh Ha	20 lakh ton
3.	America	53 lakh Ha	193 lakh ton
4.	Africa	489 lakh Ha	423 lakh ton
5.	Australia and New zealand	6 lakh Ha	12 lakh ton

Source: FAOSTAT 2021

Table 2. Indian Scenario:

S.No.	Name of the Millet	Production (million tons) 2020-21	%Contribution to total millets produced
1	Bajra (Pearl Millet)	10.86	60.5
2	Jowar (Sorghum)	4.78	22.6
3	Ragi (Finger Millet)	1.96	10.9
4	Small Millets	0.35	1.9

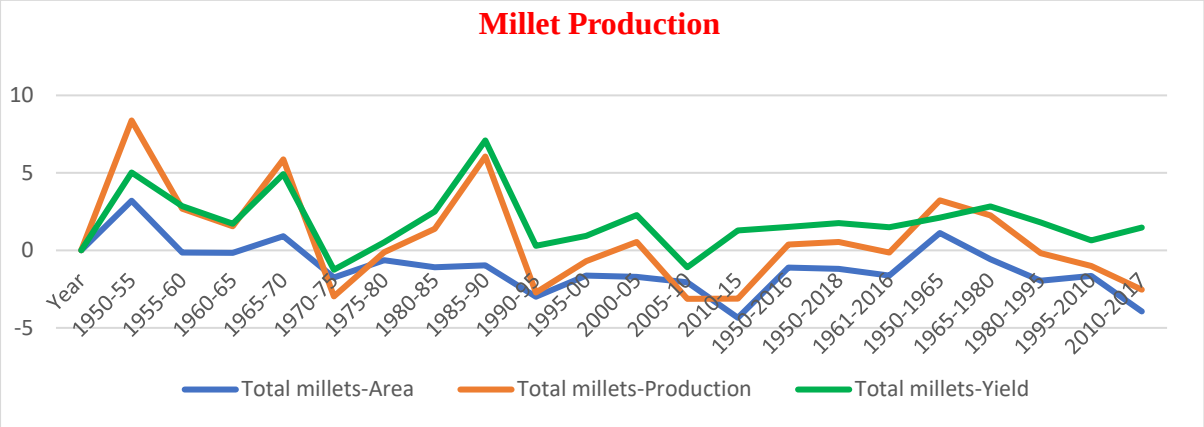
Source: Directorate of Economics & Statistics, DA&FW

Table 3. Major Millets growing states of India:

S.No.	Name of the Millet	Major States
1	Bajra (Pearl Millet)	Rajasthan, Maharashtra, Gujarat, Uttara pradesh
2	Jowar (Sorghum)	Maharashtra,Karnataka,Tamilnadu, Rajasthan,
3	Ragi (Finger Millet)	Karnataka, Maharashtra,Uttarakhand,Tamilnadu, Andhra Pradesh
4	Small Millets	Karnataka,, Maharashtra, Rajasthan, Gujarat, Uttara Pradesh, Tamil nadu, Andhra Pradesh and Telangana

Fig 1. Change in millet Production, Yield and Growing area between 1950 and 2017 in India.

ISBN: 9789358913323



In the above graph we can see the continuous decrease in the millet cultivated area between 1950 and 2017 by about 56%. On the other hand, productivity has increased by 228%, this could be attributed to the adoption of high yielding varieties with advance in agriculture.

According to the Ministry of Agriculture & Farmers Welfare, in 2016 – 2017, the area under the cultivation of millet declined with 60% or less coverage area (to 14.72 million hectares) due to change in consumption pattern, conversion of irrigated area for wheat and rice, cultivation, unavailability of millets, low yield, dietary habits, less demand. This resulted in fall in the level of nutrients like vitamin-A, protein, iron and iodine (Aliya, S.Q. and Geervani, P. ,1981) in women and children leading to malnutrition.

With regard to the Global Hunger Index – GHI, India ranks 64 among the 81 nations. India occupies second place in child malnutrition. This scenario persists inspite of the Public Distribution System and Targeted PDS, working for nearly five decades, which focused mainly on Wheat and Rice distribution neglecting the millets.

The main challenge in reviving millets as to meet the unique needs of India is to increase awareness on the multiple benefits of millets and get the public to accept millets and its taste. To bring about a larger effect it will be imperative to bring the stakeholders (producer and consumer) in the entire millet value chain to a common platform and understanding.

Indian economy is an agro-economy where agriculture sector is highly dependent on the cycle of production, distribution and consumption.

Role of millets on Indian economy is taken up in the following aspects:

- **Contribution in GDP:**
- **Largest Employee Sector:**

ISBN: 9789358913323

- **Source of Food:**
- **Relation between Agricultural and Industrial Sector:**
- **Commercial Significance:**
- **Contribution of Millets to the Government Revenue:**

CONTRIBUTION IN GDP:

India is the top producer of millets in the world and the fifth-largest exporter of millets globally. India produces 80% of Asia's & 20% of global production. The global average yield of millet is 1229 kg/ha against 1239 kg/ha in case of India.

World export of millet has increased from $400 million in 2020 to $470 million in 2021 (ITC trade map). India exported millets worth $64.28 million in the year 2021-22, against $59.75 million in 2020-21.

In 2019, millets were the world's most-traded product, with a total trade of $201M. The past few years have seen a significant rise in the global demand for millets, with global exports growing by 44.8% between 2018 and 2019. As the demand for millets rises quickly, their exports are expanding dramatically. More business opportunities are being created for entrepreneurs as millets' demand rises. The millet market has a value of over USD 9 billion in 2018 and is expected to grow at a rate of over 4.5% from 2018 to 2025, with a value projection of over USD 12 billion.

India contributes to nearly 20% of the global export value of millets and thus is a key player in terms of its ability to provide for global demand. The top export destinations include the UAE, Nepal, Saudi Arabia, and Germany. There has been more than a 50% growth in the quantity of millets exported to UAE and Nepal, which indicates an emerging market for these cereals.

LARGEST EMPLOYEE SECTOR:

In India about 54.6% of the total population is engaged in the agriculture sector, which makes it most number of employees in the country. Agriculture is an important sector of Indian economy as it contributes about 17% to the total GDP and provides employment to around 58% of the population. Rainfed agricultural conditions, requirement of minimal inputs, and indigenous know-how among farming communities make millets more relevant as an agricultural commodity in India which can increase the rural employment. Promoting millets gives visibility to women farmers and their farming wisdom who contributes in large scale to millet production. Employment generation for women through production and marketing of millet-based processed foods. Investments in Millet farming will increase the income of small and marginal farmers in India.

ISBN: 9789358913323

SOURCE OF FOOD:

In Indian Agriculture, millets were once the highest consumed among the food crops, after 1970s to till recently, millet has occupied a relatively lower position though they are really important from the point of food security at the regional and household level.

India accounts for 38% of the millet consumption of its domestic produce. Government has recognized the role of millets in the food chain. Under the National Food Security Mission (NFSM) preliminary targets for enhancing food grain production by an additional 25 Million Tonnes, the share allocated for millets is 2 Million Tonnes i.e. 8% of the enhanced food grain production.

Importance of Millets as food

1. Most of the millets are non-acid forming, non-glutinous, highly nutritious, and easily digestible foods (Nirmala *et al* 2000). Due to low glycaemic index (GI) being gluten-free, it helps in a slower release of glucose over a longer period of time thus reducing the risk of diabetes mellitus. Individuals suffering from celiac disease can easily incorporate various millets in their diets.
2. Millets are rich sources of minerals like calcium, iron, zinc, phosphorus, magnesium, and potassium(Anthony and Chandra, 1998) . It also contains appreciable amounts of dietary fibre, Protein and vitamins such as folic acid, vitamin B6, β- Carotene, and niacin (Ravindran, 1992). The availability of high amounts of lecithin is useful for strengthening the nervous system. Therefore, regular consumption of millets can help to overcome malnutrition.
3. Although Millets are rich in phytochemicals like tannins, phytosterols, polyphenols and antioxidants, they do contain some anti-nutritional factors which can be reduced by certain processing treatments (Rajyalakshmi and Geervani, 1990).
4. Millets have a wide capacity for adaptation because they can grow from coastal regions of Andhra Pradesh to moderately high altitudes of North-eastern states and hilly regions
5. of Uttarakhand. Millets can withstand variations in moisture, temperature and the type of soils ranging from heavy to sandy infertile lands.
6. Studies by IIMR, Central Food Technological Research Institute (CFTRI) &ICRISAT focus on Health benefits & clinical evidences, Nutrition & bioavailability of nutrients- focussing on Diabetics, suitability for school children, Bone Health and Nutrition Profiling.

ISBN: 9789358913323

Therefore, to ensure food and nutrition security for our country, it is important to increase the production of these crops and simultaneously revert the control of production, distribution and consumption back to the people through Public Distribution System.

RELATION BETWEEN AGRICULTURAL AND INDUSTRIAL SECTOR:

In India industrial sector is highly dependent on agricultural sector as around half of the income generated in this sector comes from agricultural based industries. Millets with its super food and infancy status can definitely give enormous contribution in terms of raw materials for food processing and other related industries. Investing in the Millet ecosystem provides an opportunity to the industrialists to create an impact on society and the environment to meet the demand for nutritious food and to cater to the food security challenges.

COMMERCIAL SIGNIFICANCE:

Millets are part of the agricultural sector, is important for both industrial and trading purposes on domestic and global scale. Agriculture sector, which already contributes 70% of the country's total export can exceptionally benefit by increased production of millet and its based food products.

Indian Institute on Millet Research (IIMR), under RKVY-RAFTAAR, has incubated 250 start-ups and INR 6.2 crores disbursed to over 66 startups with additional of 20-25 startups approved for further funding. Startups spread across the entire value chain of millets, Primary Processing, RTE, RTC like Breakfast Cereals, Millet Coffee, Pizza Flours, Porridge, Flakes, Puff etc

MoFPI (Ministry of Food Processing Industries) included Production Linked Incentive (PLI) scheme for millet products, task force for bringing all processors, stakeholders under one umbrella (Corporate Led).

Research & Development on traditional/contemporary millets recipes by IIMR, CFTRI & National Institute of Food Technology, Entrepreneurship and Management (NIFTEM) depict

higher shelf life with proper packaging, branding & ready to use products. Development of recipes, books & online modules through chef's & hotel management schools.

ISBN: 9789358913323

CONTRIBUTION OF MILLETS TO THE GOVERNMENT REVENUE:

Agriculture is the most significant source of income for both central and state governments. The movement of agricultural goods interms of higher production and yield of millets enormously increase revenue generation for the Indian railways which in turn the government.

Important Advantages of the millet crops in terms of low carbon foot print, low water requirement and high nutrition status of these crops helps to overcome malnutrition problems.

Millets have often been called the coarse grains, because of their nutritional contributions they are now being referred to as 'nutria-millets or nutria-cereals'(Rao et al 2011). Millets are termed as the 'miracle grains' or 'crops of the future' as they can not only grow under harsh circumstances but are drought-resistant crops that require fewer external inputs. Production of millets does not depend on the use of chemical fertilizers. The millet crops do not attract pests and are not affected by storage. Millets are dual-purpose crops and cultivated both as food & fodder, thus providing food/livelihood security to millions of households (Adekunle *et al*, 2018). Millets contribute to mitigating climate change as it helps reduce the atmospheric carbon dioxide pressure. On the contrary, wheat being a thermally sensitive crop and paddy, the major contributor to climate changes through methane emission.

Despite numerous qualities, utilization of millets as food is confined to the traditional consumers i.e. tribal populations. This is mainly because of the non-availability of consumer-friendly ready-to-eat millet-based products.

To increase the role of millets on huge scale on Indian economy there should be increase in both production and consumption which create huge foreign exchange resource for the country. The Indian policymakers refocused their attention towards millet farming systems and enacted policies to create an enabling environment for the farmers in terms of various schemes with respect to millets production like Integrated Cereals Development Programmes in Coarse Cereals (ICDP-CC) and Initiative for Nutritional Security through Intensive Millet Promotion – INSIMP a part of Rashtriya Krishi Vikas Yojana

In this regard lot of Awareness and out reach programme is essential. Government has declared **2018 as Year of millets in India** and has also made United Nations to declare 2023 as **International Year of Millets**. Some of the important programmes are :

ISBN: 9789358913323

DOMESTIC OUTREACH

Food festivals: Cyclothons: Marathons: Millet recipe awareness. Cooking workshops. Conference by Industry Associations, Food processing interventions by industry. Millet Export opportunities- APEDA workshops –focus on organic, National consultation on Millets policy mainstreaming.Workshops with dieticians, doctors, nutritionists, civil society, students. . Millet recipes food festivals - Eat Right India. Celebrity Endorsements, Hackathons/ Start Up challenges (Mechanization, Supply chain and Logistics, Post-Harvest, Food Technology& Value Addition)

ACTIVITIES BY THE STATES:

Distribution of millets through ICDS (Integrated Child Development Services) once a week. Different stakeholders to be involved with events in millet producing districts. Conferences at district & state level for promotion of millets – focus on Nutrition and Health benefits of Millets for Immunity and Nutritional security. Establish Centres of Excellence on nutri-cereals across the length and breadth of India.

MASS AWARENESS:

Mid-Day Meal in schools & Anganwadis at least one day a week, Buffets at hotels to have millet focus at least one millet dish during 2023. Online platforms and delivery agents to popularize millets. Organize events in various groups (using NSS, NCC SHGs/FPOs), schools, colleges, universities, industry and civil societies.

Engage Industry bodies like Confederation of Indian Industry (CII), Federation of Indian Chambers of Commerce and Industry (FICCI), Encourage and support the print, social and electronic media

Defence Food and Research Lab to promote millets in Defence, Police forces& Canteens. Establish scholarships to support 10 meritorious students at Agri Universities

INTERNATIONAL OUTREACH:

Facilitating dialogues between key players and investors in target countries to enhance trade of Millets. G2G engagements to collaborate on food security agreements and MoUs. Conducting Millet based food festival to promote the products made of Millets GLOBAL PROMOTION- (FAO) ACTION PLAN FOR IYOM (International Year Of Millets)- IYOM 2023

ISBN: 9789358913323

CONCLUSION

India is mainly agricultural country where agriculture constitutes $1/10^{th}$ of the total exports. Considering food security and climate change, millets constitutes an important substituent for Rice and Wheat, both in terms of nutrition and water requirement.

Nutrition security implies awareness and access at affordable cost to balanced diet, safe environment and drinking water and health care outreach. Millets contribute towards balanced diet as well as safe environment. They are nature's gift to humankind. Millets are a treasure-trove of micronutrients like B-complex vitamins and minerals whose deficiencies in India are rampant. Processing can improve the bioavailability of nutrients as well as functionality (Agte and Joshi 1997). Millets are drought,

temperature and pest tolerant and hence are grains for the future in an environment of climate change and global warming. Some recent initiatives to rejuvenate millets from production to Consumption, include: "Initiative for Nutritional Security through Intensive Millets Promotion" (INSIMP), under the Rashtriya Krishi Vikas Yojna of Government of India, "Revalorising Small Millets in the Rain-fed regions of South Asia (RESMISA) funded by International Development Research Centre (IDRC) and CIDA (Canadian funds), and National Academy of Agricultural Sciences 13 DSR-led value chain development approach for commercialisation of Millets.

The use of Millets in commercial packaged food will encourage farmers to grow them on larger scale and gives new opportunities and revitalization to farmers. The inclusion of Millets based food in state, national and international level programmes help to overcome nutrient deficiency of protein, calcium and Iron. India being the highest producer of Millets and 5^{th} largest exporter globally the increased production will exponentially increase the India's export contributing substantially to our foreign exchange reserve.

It is impossible to overstate the importance of excellent nutrition and healthy food, especially in the wake of the recent pandemic. Millets has several advantages, including low-maintenance, disease resistance, nutritional value, market demand, fodder value, and ecological benefits, which helps in sustainability of Indian agricultural sector. In reality, millet's adaptability and ease of cultivation are reviving interest in it.

FINALLY, WE CAN SAY MILLETS ARE THE FUTURE OF FOOD AND FARMING which play very important role in Indian Economy.

ISBN: 9789358913323

REFERENCES:

1. Adekunle, A., Lyew, D., Orsat, V. and Raghavan, V., 2018. Helping agribusinesses—Small millets value chain - to grow in India. Agriculture
2. Agte, V. and Joshi, S.R. (1997). Effect of traditional food processing on phytate degradation in wheat and millets. J. Agric. Food. Chem., 45: 1659-1661.
3. Aliya, S.Q. and Geervani, P. (1981). An assessment of the protein quality and vitamin B content of commonly used fermented products of legumes and millets. J. Sci. Food. Agric., 32: 837-842.
4. Antony, U. and Chandra, T.S. (1998). Antinutrient reduction and enhancement in protein, starch and mineral availability in fermented flour of fingermillet (Eleusine coracana). J. Agric. Food Chem., 46: 2578-2582.
5. Nirmala, M., Subba Rao, M.V.S.S.T and Murli krishna, G. (2000). Carbohydrates and their degrading enzymes from native and malted finger millet (Ragi) Eleusine coracana, Indaf-15). Food Chem. 69:175-180.
6. Rajyalakshmi, P. and Geervani, P. (1990). Studies on tribal foods of south India: effect of processing methods on the vitamin and in vitro protein digestibility of cereals/ millets and legumes. J. Food Sci. Technol., 27: 260-263.
7. Rao, B.R., Nagasampige, M.H. and Ravikiran, M. (2011). Evaluation of nutraceutical properties of selected small millets. J. Pharm. Bioall. Sci. 2011 [cited 2013 Apr 21]; 3:277-9.
8. Ravindran, G. (1992). Seed proteins of millets: amino acid composition, proteinase inhibitors and in vitro digestibility. Food Chem., 44(1): 13-17.
   https://krishijagran.com/?amp=1&utm_source=AMP&utm_medium=MENU&utm_campaign=AMP_NAV_LINKS&utm_id=KJ_AMP_PAGES.
   https://unacademy.com/content/ssc/study-material/general-awareness/importance-of-millets/
   https://impactentrepreneur.com/the-global-impact-economy-of-millets/
   https://economictimes.indiatimes.com/news/economy/agriculture/millets-to-increase-income-of-small-and-marginal-farmers-govt/articleshow/97828596.cms
   https://www.drishtiias.com/daily-updates/daily-news-editorials/india-s-millet-revolution
   https://www.insightsonindia.com/agriculture/role-of-agriculture-in-indian-economy/
   https://unacademy.com/content/ssc/study-material/indian-economy/role-of-agriculture-in-the-indian
   Economy/#:~:text=In%20India%2C%20around%20half%20of,dependent%20on%20the%20agricultural%20sector.https://www.millets.res.in/books/Policy66.pdf.

ISBN: 9789358913323

4. REVIEW OF FINGER MILLET (RAGI) (ELEUSINE CORACONA (L.) GAERTN) - A FUNCTIONAL FOOD AS PORRIDGE FOR INFANTS

Smt. M.R.Chaya
Associate professor, Department of Chemistry, KLE Society S.Nijalingappa College, Bengaluru

Abstract:

Finger millet is amongst the major crops of South Karnataka. Finger millet has higher nutritional content and outstanding subsistence properties. The chemical composition of finger millet revealed that the total carbohydrate content of finger millet ranged from 72 to 79.5%. Although finger millet contains nearly 7% protein, various studies have found large variations in protein content ranging from 5.6 to 12.70%. The total ash content of finger millet is higher than that of commonly consumed cereal grains. The ash content of finger millet has been found to be between 1.7 and 4.13%. The calcium content of 36 finger millet genotypes ranged from 162 to 487 mg%. Finger millet is the richest source of calcium and iron. Calcium deficiency, which causes bone and tooth disorders, and iron deficiency, which causes anaemia, can be overcome by including finger millet in our daily diet. Traditional weaning foods for infant-feeding practised in India, are usually cereal based. Finger millet in combination with milk solids are generally used for the preparation of porridge. In addition to exploring the nutritional qualities and potential health advantages of Finger Millet, this review aims to examine how finger millet is used to prepare various cereal dishes, mostly porridges, utilising various processing techniques. Due to its useful components, finger millet has become more significant as the consumption of processed foods has changed and consumers have become more conscious of their health benefits. So, it is essential to find the judicious mixture of both of these components through adequate study if you want to gain from the functional components of Finger Millet and milk.

Keywords: Finger millet, Porridge, Nutritional value

Introduction:

Nutritional well-being is a long-term force for health and development, as well as the maximisation of human genetic potential. As a result, a community's nutritional status has been identified as an important indicator of national development. In other words, malnutrition is a barrier to national development and thus qualifies as a national problem. Dietary quality should be considered when addressing the problem of widespread food insecurity and malnutrition. Growing traditional food crops that are appropriate for the area is one of the potential successful approaches to improving household food security.

ISBN: 9789358913323

Finger millet, also known as Ragi and Mandua in India, is a minor cereal native to Ethiopia that is grown extensively in various regions of India and Africa. It is a staple food that provides a significant portion of calories and protein to large segments of the population in these countries, particularly low-income people [1]. Karnataka is India's leading producer of finger millet, accounting for 58% of global production, but only a few Indians are aware of its health and nutritional value. Finger millet production in India ranks sixth after wheat, rice, maize, sorghum, and bajra. Ragi/Finger Millet is an important cereal that has the highest area under cultivation among small millets and is high in iron [2](Tatala et al., 2007), magnesium (Guigliano, 2011)[3], and dietary fibre[4] (Devi et al., 2014). Ragi has also gained popularity due to its functional components, which include slowly digestible starch and resistant starch [5] (Wadikar et al., 2007). It is a simple grain with a low glycemic index, making it ideal for diabetics [6] (Pradhan et al., 2010).

Finger Millet is traditionally processed through malting or fermentation. Finger Millet flour, both malted and fermented, is widely used in the production of weaning foods, instant mixes, beverages, and pharmaceutical products [7](Rao and Muralikrishna, 2001)

Finger Millet porridge serves as an ideal low calorie diet for all age groups especially growing infants and pregnant women. Finger Millet has some of the inherent qualities, which makes it superior compare to other cereals and also qualify for malting and preparation of malted foods. It is resistant to fungal infection; elaboration of alpha and beta amylase takes place during germination and during roasting/ kilning, a desirable aroma is developed, which makes it an ideal grain for malt foods. Keeping in view the above mentioned facts, this review has been presented here to attract the attention of future workers for development of novel technology to prepare ready to serve milk based Finger Millet porridge for commercial exploitation to the entrepreneurs and industry.

Traditional weaning foods for infant-feeding practised in India, are usually cereal based. Cereals including finger millet in combination with milk solids are generally used for the preparation of porridge.

In ancient India, poets were offered finger millet boiled in milk with honey [8](Achaya, 1992). Red finger millet's pinkish flour was consumed as a gruel or ball that was either salted or sweetened. Additionally popular as weaning foods was finger millet [9](Achaya, 2009)

For children of weaning age, [10]Mbithi-Mwikya et al. (2002) created a finger millet based supplemental diet that includes Kidney beans (Phaseolus vulgaris), Peanuts (Arachis hypogoea), and Mango (Mangifera indica). The lactic acid fermentation, autoclaving, and germination of finger millet and kidney beans produced improved outcomes. They suggested a 33% (w/v) pap (soft diet) created from this mixture, which, at three servings per day and an average breastfeeding frequency,

ISBN: 9789358913323

has an energy density of 5.4 kJ/g of pap and is sufficient to meet the energy needs of well-nourished children between the ages of 6 and 24 months. Based on malted finger millet and green gramme, Malleshi and Desikachar (1982) [11] developed a weaning food with low hot paste viscosity (Phaseolus radiatus). For added value, some researchers (Malleshi, 2007[12]; Shobana et al., 2013[13]; Verma and Patel, 2013[14]) refined the nutritional and technological aspects of finger millet porridges even more.

Health benefits of finger millet

Antioxidant:

Sripriya et al. (1996)[15] reported that DPPH radical quenching with 50 µl of the extracts brown finger millet quenched 94% whereas the white finger millet quenched only 4%. According to Rajasekaran et al. (2004)[16], finger millet feeding increased the skin's antioxidant level, which sped up the healing of dermal wounds.

Antibacterial:

Varsha et al. (2009)[17] assessed the antioxidant and antibacterial capabilities of finger millet polyphenols' and their findings suggested that there is potential to use finger millet seed coat as an alternate natural food preservative and antioxidant.

Anti-diabetic:

Brown finger millet has 96% greater phenol content than the white version. Finger millet based Diets significantly decreased plasma glucose levels, mean peak increase, and area under the curve, which could have been caused by finger millet's increased fibre content when compared to wheat and rice. Millets enhance insulin responsiveness and reduce blood sugar levels (Lakshmi and Sumathi, 2002)[18]

Mineral content:

The millet grain's mineral profile varies greatly. The mineral content of these food grains is influenced by genetic factors and the local environment in the growing region. With a very high amount of calcium and potassium when compared to other millets or cereals, finger millet is a highly nutritious food. It is rich in minerals like: Calcium, Potassium, Iron, and Magnesium &Zinc. Compared to other regularly consumed cereal grains, finger millet has greater total ash content. In finger millet, the ash level ranged from around 1.7. Srivastava and Sharma (2012)[19]reported that , finger millet is not only a rich source of calcium but contains also other micronutrients essential for good health. Shashi et al. (2007) [20] reported that phosphorus from millets is an important mineral for energy production and is an essential component of Adenosine Triphosphate (ATP) – the energy store of the body. Incorporation of finger millet beverage at 75% level in children food

ISBN: 9789358913323

for six months resulted significantly increase in haemoglobin concentration than in the non-fortified group (Tatala et al., 2007) [21].

Nutritional value of home-made Finger millet Porridge per 100 gm

Data based on IFCT (Indian Food Composition Tables)

- National Institute of Nutrition (2017)

Energy	320 Kcal
Protein	7.16 g
Carbohydrates	66.82 g
Fat	1.92 g
Dietary fiber	11.18 g
Iron	4.62 mg.
Sodium	11 mg.
Calcium	364 mg.
Potassium	443 mg.
Magnesium	146mg
Phosphorus	210mg
Manganese	3.19mg
Zinc	2.53mg
Vitamin B1 (thiamin)	0.37mg
Vitamin B2 (riboflavin)	0.17mg
Vitamin B3 (niacin)	1.34mg
Vitamin B6 (pyridoxine)	0.05mg
Vitamin K	0.9mcg
Carotene	42 μg.
Total folates	34.66 μg.

Conclusion:

It is rich in calcium and easily digestible, because of which it is used as a weaning food for babies aged six months and older. Regardless of the nutritional value of finger millet and its many health benefits, it is not consumed often because of its bland taste. However, it tastes good after roasting or mixing with other ingredients. The combination of milk and Finger millet to create porridge can be crucial for the flavour and enjoyment of food as well as for the high

ISBN: 9789358913323

nutritional value and benefits for youngsters and the elderly. Finger millet's food usage could be enhanced by processing it using both conventional and modern techniques to make convenience foods like porridge. In order to fill the growing gap between the availability of food and nutritional security, the modern trend for developing new food products aspires for supplementary foods. For the readymade food sector, innovation in the generation of value-added dairy products is a tremendous economic opportunity.

References

1. M.M. O'Kennedy, A. Grootboom, P.R. Shewry Harnessing sorghum and millet biotechnology for food and health J. Cereal Sci., 44 (3) (2006), pp. 224-235
2. Tatala, S., Ndossi, G., Ash, D. and Mamiro, P. (2007). Effect of germination of finger millet on nutritional valueof foods and effect of food supplement on nutrition and anaemia status in Tanzanian children. Tanzania Health Res. Bull. 9(2): 77–86
3. Guigliano, R. P. (2011). Niacin at 56 years of age – time for an early retirement. The New England J. Med. 365: 2318-2320.
4. Devi, P.B., Vijayabharathi, R., Sathyabhama, S., Malleshi, N. G.,and Priyadarshini, V. B. (2014). Health benefits of finger millets (Eleusine coracana L.) polyphenols and dietary fiber: A review. J. Food Sci. Technol. 51(6): 1021-1040.
5. Wadikar, D. D., Premvalli, R. S., Satyanarayanswamy, Y. S. and Bawa, A. S. (2007). Lipid profile in finger millet. J. Food Sci. Technol. 44(1): 79-81.
6. Pradhan, A., Nag, S. K. and Patil, S. K. (2010). Dietary management of finger millet controls diabetes. Current Sci. 98(6): 763-765.
7. Rao, S. M. V. S. S. T. and Muralikrishna, G. (2001). Non starch polysaccharides and bound phenolic acids from native and malted finger millet (Ragi, Eleusine coracana, Indaf-15). Food Chem. 72: 187-192.
8. Achaya, K.T. (1992). Indian food: A historical companion. USA: Oxford University Press.
9. Achaya, K.T. (2009). The illustrated food of India A-Z. New Delhi, India: Oxford University Press.
10. Mbithi-Mwikya, S., Van Camp, J., Mamiro, P. R., Ooghe, W., Kolsteren, P., and Huyghebaert, A. (2002). Evaluation of the nutritional characteristics of a finger millet based complementary food. J. Agri Food Chem. 50(10): 3030- 3036.
11. Malleshi, N. G. and Desikachar, H. S. R. (1982). Formulation of a weaning food with low hot-paste viscosity based on malted ragi (Eleusine coracana) and Volume-02, Issue-04, April-2017 RESEARCH REVIEW International Journal of Multidisciplinary © RRIJM 2015, All Rights Reserved 18 | P a g e green gram (Phaseolus radiatus). J. Food Sci. Technol. 19: 193–197.
12. Malleshi, N. G. (2007). Nutritional and technological features of ragi (finger millet) and processing for value addition. In: K. T. Krishne Gowda and A. Seetharam (Eds.), pp.9-19. Food uses of small millets and avenues for further processing and value addition, project coordination cell, All India Coordinated Small Millets Improvement Project,Icar, UAS, GKVK, Banglore, India.

ISBN: 9789358913323

13. Shobana, S., Krishnaswamy, K., Sudha, V., Malleshi, N. G., Anjana, R. M., Palaniappan, L. and Mohan, V. (2013). Finger Millet (Ragi, Eleusine coracana L.): A review of its nutritional properties, processing, and plausible health benefits. Adv Food Nutr. Res. 69: 1043–4526.

14. Verma, V. and Patel, S. (2013). Value added products from nutri-cereals: Finger millet J. Food Agri. 25(3): 169-176.

15. Sripriya, G., Chandrasekharan, K., Murthy, V. S. and Chandra, T. S. (1996). ESR spectroscopic studies on free radical quenching action of finger millet (Eleusine coracana). Food Chem. 57(4): 537–540.

16. Rajasekaran, N. S., Nithya, M., Rose, C., and Chandra, T. S. (2004). The effect of finger millet feeding on the early responses during the process of wound healing in diabetic rats. Biochemica et Biophysica Acta. 1689: 190–201.

17. Varsha, V., Urooj, A. and Malleshi, N. G. (2009). Evaluation of antioxidant and antimicrobial properties of finger millet (Eleusine coracana) polyphenols. Food Chem. 114(1): 340–346.

18. Lakshmi Kumari, P. and Sumathi, S. (2002). Effect of consumption of finger millet on hyperglycemia in non-insulin dependent diabetes mellitus (NIDDM) subjects. Plant Foods Human Nutr. 57: 205–213.

19. Srivastava, K. and Sharma, A. K. (2012). Neutraceutical importance of finger millet (Eleusine coracana) for improved human health. Eur. J. Plant Sci. Biotechnol. 6 (2): 91- 95.

20. Shashi, B. K., Sharan, S., Hittalamani, S., Shankar, A. G. and Nagarathna, T. K. (2007). Micronutrient composition, antimicronutirent factors and bioaccessibility of iron in different finger millet (Eleusine coracana) genotype. Karnataka J. Agri. Sci. 20(3): 583-585.

21. Tatala, S., Ndossi, G., Ash, D. and Mamiro, P. (2007). Effect of germination of finger millet on nutritional value of foods and effect of food supplement on nutrition and anaemia status in Tanzanian children. Tanzania Health Res. Bull. 9(2): 77–86.

ISBN: 9789358913323

5.FOXTAIL MILLET: NUTRITIONAL VALUE AND HEALTH BENEFITS IN BAKERY INDUSTRY

Soumya Hiregoudar*, Mamatha, H. S.** and M. L. Revanna***

*Ph.D. Scholar, Food Science and Nutrition, University of Agricultural Sciences, GKVK, Bengaluru- 560065, Email: soumyashiregoudar@gmail.com

**Associate Professor, Food Science and Nutrition, University of Agricultural Sciences, GKVK, Bengaluru- 560065

***Professor, Food Science and Nutrition, University of Agricultural Sciences, GKVK, Bengaluru-560065

Abstract

As people are becoming very health conscious and would like to consume foods containing high fiber, low fat and other protective nutrients. The increase in the disposable income, changing tastes and preference, rising foreign influence etc. of people forced the bakery industry to looking forward for newer options to ingredients having functional and nutracaeutical properties. It is promising to replace the refined wheat flour in bakery industry to a certain degree by using other cereal grains, as refined wheat flour is considered nutritionally poor because it is deficient in fiber, essential amino acids such as lysine and threonine. Millets contain abundant phytochemical and micronutrients and due to these nutritional benefits, millets are termed as "nutri-cereals". Among the millet, foxtail millet (*Setaria italica*) is one of the oldest cultivated crops, grown in arid and semiarid regions of Asia and Africa. Foxtail millet provide a wide range of health benefits and are good source of fibre, energy, proteins, minerals and vitamins. Proteins in millet are good source of essential amino acids excluding lysine and threonine but contain higher amount of methionine. Due to coarse character of foxtail millet grains, the edible amount contains about 79% and the remaining non-edible part of the grain contains high levels of fibre and some anti-nutritional components. The millet is reported to possess several health benefits like prevention of cancer, hypolipidemic, low-glycemic index and antioxidant characteristics. In view of this, there is an extensive scope for millets exploitation in development of different bakery products like breads, biscuits, cakes, cookies etc. Millet flour can be considered as a good alternative for refined wheat flour in bakery industry with proper processing technique.

Key words: Foxtail millet, Nutritive value, Health benefit, Bakery industry

ISBN: 9789358913323

Introduction

The whole grains of millets are good source of energy, protein, fiber, minerals and vitamins, additional benefits of the millets like gluten-free protein content and low glycemic index. Millets rank sixth in the world cereal grain production. In Africa and Asia, these underutilized grains play a major role in the food security of millions of people. They can strongly resist the conditions of drought and even can grow in rain fed region. India is known to be the leading producer of both large and small millets. Considering their climate resilience, role in nutritional and health security, the Government of India has declared the year 2018 as "National year of Millets" and year 2023 as "International Year of Millets" by United Nations. These nutri-cereals harbor vitamins, minerals, essential fatty acids, phyto-chemicals and antioxidants can help to eradicate the plethora of nutritional deficiency diseases. Millets cultivation can keep dry lands productive and ensure future food and nutritional security.

Millets are orphan crops with tremendous potential but underexplored source of nutraceutical properties as compared to other regularly consumed cereals. Regular consumption of millets can reduce the chance of various live threatening diseases such as diabetes, obesity, cardiovascular diseases, osteoporosis and even age-associated diseases. It is not common in our diets so the chance of incorporating it into various types of food products holds a vast scope to study and research for scientific rationalization of its health healing properties and moreover millets can also probably transform food products into magical food products, i.e., super foods using various agri-processing and other modern technologies integrating the fundamental knowledge of genomics, bioinformatics, biotechnology and nanotechnology. Promotion of millets production and value addition contribute significantly to meet many of the Sustainable Development Goals (SDGs).

Millets also called small millets are cultivated for their small kernels which are the products of small grassy plants belonging to the *Poaceae* family. The other name minor millets may indicate them to be minor crops yet are important for their nutritional values, medicinal benefits, feed for animals and saviors during food crisis. The word "millet" has originated from the French word "Mile" meaning thousand which implies a handful of millets contain thousands of grains. Millets are often grown in semi-arid conditions with very less rainfall and marginal or degraded lands with very low nutrient contents. The crops support the livelihood of people in areas where famine is a regular phenomenon and the millets yield a more dependable harvest compared to other crops in low rainfall areas.

ISBN: 9789358913323

Millets are plants with very superior photosynthetic efficiency, short duration, higher dry matter production capacity and a high degree of tolerance to heat and drought. They also easily adapt to degraded saline, acidic and aluminum toxic soils. These extraordinary characters of millets make them suitable crops to tackle the hurdles of climate change and formulate millet-based climate resilient technologies. The modern sedentary lifestyle associated with several health issues has urged people to seek for healthy and nutritious diets. Small millets satisfy these requirements of modern society by being a healthy food choice because millets are a storehouse of nutrient and, in particular, finger millet grains contain remarkably high calcium content (>350 mg/100 g); foxtail millet, barnyard millet, and proso millet are prosperous in protein (>10%); little millet and foxtail millet are well-off in fat (>4.0%); foxtail millet, barnyard millet, and little millet are superior in crude fiber (6.7–13.6%), barnyard millet and little millet contain high amount of iron (9.3–18.6 mg/100 g) in comparison to other major cereals like rice, wheat, barley, maize and sorghum. The increase in demands of millets in both national and international markets have triggered the interests of researchers to collect, conserve and utilize the germplasm available globally for their important traits in crop improvement, development of genomic resources and value addition. Recently several private organizations have ventured into value addition and marketing chain of millets that has boosted millet cultivation and consumption. In this process, the government has a role to play by formulating suitable policies in order to motivate cultivation, marketing and consumption of millets to achieve food and nutritional security. There are no less than 14 species of millets belonging to 10 genera, that include pearl millet (*Pennisetum glaucum L.*), foxtail millet (*Setaria italica L. subsp. italica*), Finger millet (*Eleusine coracana L.*), barnyard millet (*Echinocloa esculenta A. and Echinocloa colona L.*), proso millet (*Panicum miliaceum L. subsp. miliaceum*), kodo millet (*Paspalum scrobiculatum L.*), and little millet (*Panicum sumatrense Roth.*) that are cultivated widely throughout the world. However, the study of literature on millets is very cumbersome because of different common names and vernacular names given to the same species of millets and they are usually studied as minor cereals.

Foxtail millet (*Setaria italica L. subsp. italica*): The probable center of origin of Foxtail millet or Italian millet is China; however, the crop is known to be domesticated during Neolithic culture. It is among one of the ancient cereals cultivated in Europe and Asia, with China contributing more than 45% of world production. The crop is well adapted to cooler climates and matures in less than 70–120 days. Foxtail millets, magical millets or miracle grains are natively known as Navane, Kangni, Kang and kakum. These are tiny seeds covered in a thin, crispy hull and are available in a light yellow-brownish colour. The cultivation of foxtail millets (*Setalica italia*) began in 8700 BC in China. In India, these are widely grown in Karnataka, Andhra Pradesh, Maharashtra and Tamil Nadu. There are three to four foxtail varieties available in the market, namely Moharia, Maxima,

ISBN: 9789358913323

Nana and Indica. Foxtail millets have a sweet and nutty flavour and are eaten as instant foods, ready-to-eat products, rice flour, etc. Apart from the culinary uses, it is a farmer-friendly and health-friendly crop; making it “good for you” (due to its nutritional value), and “good for the world” (as it requires less water and other factors for cultivation). Foxtail millet are Soluble and insoluble bound phenolic extracts present in the seeds show antioxidant, metal chelating, and metal reducing powers, they reduce toxicity caused by xenobiotics and toxins in the body, high amount of proteins and essential amino acids helps in building body tissues and advised for infants and elderly people.

Nutritional Composition of millets

Name of the millet	**Nutritional composition (/100 g)**						
	Energy (kcal)	Protein (g)	Fat (g)	Carbohydrate (g)	Crude fiber (g)	Iron (mg)	Calcium (mg)
Finger millet	328	7.3	1.3	72.0	3.6	3.9	344
Barnyard millet	307	6.2	2.2	65.5	9.8	15.2	11
Kodo millet	309	8.3	1.4	65.5	9.0	0.5	27
Pearl millet	361	11.6	5.0	67.5	1.2	16.9	38
Little millet	341	7.7	4.7	67.0	7.6	9.3	17
Proso millet	341	12.3	1.1	70.4	2.2	0.8	14
Foxtail millet	**331**	**12.5**	**4.3**	**60.9**	**8.0**	**2.8**	**31**

Processing of millets for bakery products

Millets can be used for making a variety of bakery products such as bread, cakes, cookies, and muffins. However, millets have some unique properties that require certain processing techniques

ISBN: 9789358913323

to be used in baking. Here are some of the processing techniques that are commonly used for millets in bakery products:

Dehulling: Millet grains are usually covered with a tough outer layer called the hull. Dehulling is the process of removing the hull from the grain. Dehulled millets are easier to digest and cook faster. Dehulling also reduces the bitterness of some types of millets.

Milling: Millets can be ground into flour using a mill. Millet flour can be used as a substitute for wheat flour in baking. However, millet flour is gluten-free and does not have the same elasticity as wheat flour. Millet flour is best used in combination with other gluten-free flours such as rice flour or corn flour.

Fermentation: Millets do not have gluten, which makes it difficult to create a well-risen bread. To overcome this, millet flour can be fermented with the help of sourdough starter or yeast. Fermentation helps to break down the complex carbohydrates in the millet flour, making it easier to digest and also enhancing its flavor.

Soaking: Some types of millets, such as pearl millet, can be quite tough and difficult to cook. Soaking millets overnight in water can help to soften them and reduce the cooking time. Soaking also helps to release some of the nutrients in the millet, making them more bioavailable.

Mixing: When baking with millet flour, it is important to mix it well with other flours and ingredients to ensure a good texture and flavor. Millet flour can be mixed with other gluten-free flours such as rice flour or corn flour, as well as with wheat flour for a gluten-containing option.

In conclusion, millets can be a healthy and nutritious ingredient in bakery products, but they require certain processing techniques to ensure good results. Dehulling, milling, fermentation, soaking, and mixing are some of the common processing techniques used for millets in bakery products.

Important Food and Non-food Products Prepared from Millets

The millets are cultivated in semi-arid conditions on marginal lands by small and marginal farmers and consumed throughout Asia and Africa for more than 3000 years. But, recently millets have gained huge demands in national and international markets because of their superior nutritional values along with several health benefits. There are a large number of traditional millet-based foods and beverages prepared and consumed in different parts of Asia, Africa, Indian subcontinent and East Asia. They can be characterized into wholegrain foods, meal or flour-based foods, nonalcoholic and alcoholic beverages.

ISBN: 9789358913323

Food Products from Millets

Whole Grain Foods

Popping the grains: The popping process involves moistening the grains to 19% moisture content, tempering the grains for several hours, agitating the grains in hot sand bed (240 _C) for a few minutes. The outer pericarp is removed and the popped grains are consumed as a snack or further processed by milling, e.g., pearl millet, finger millet, and foxtail millet.

Germinated seeds: The seeds are soaked overnight and allowed to germinate the protein, mineral, and vitamin content increases after seed germination. The seeds are then consumed raw or cooked. Germinated seeds are advised for infants and elderly people, e.g., finger millet, little millet, and kodo millet.

Direct cooking: Rice like product called Kichadi is prepared by cooking the whole grains, e.g., Pearl millet, Foxtail millet, Kodo millet, and Little millet.

Foods made from Flour

Flat breads: The millet flours undergo a specialized fermentation treatment with yeast and lactic acid bacteria that yields soft leavened textured bread with acidic flavor. The two most famous flatbreads in Africa are kisra and injera that are thin, flexible wafers with a spongy texture and are relished with spicy sauce.

Rotis or chapatis: These are the most well-known unfermented flatbreads made from millets and are popular staple foods of India. Rotis or chapatis resemble a soft pancake with a flexible puffed texture. They are usually served with pickles, vegetables, chutney, meat, or sauce.

Dosa and Idli: These products are popular in southern parts of India, the semifermented millet flour is used in making dosas and idlis, that are served with sambar or chutney.

Biscuits, Cookies and Cake: The bakery products most consumed by all age group people on daily basis. Incorporation of millet flour in bakery products enhances the nutritional value of the bakery products.

Bakery Products

Several bakery products available in the market such as biscuit, muffins, and bread can be prepared by using millet flour. Although millet flours are gluten-free which is not favorable for use of entirely pure millet ingradients for preparation of bakery. Use of millet flour in preparation of bakery products enriches them in fiber and micronutrients which enhance the

overall quality and value of products. It was found that the addition of millet flour improves the nutritional and function properties of cake-like products. Development of convenient food using millets and sorghum variety. Used for formulation of food products using millets found that

ISBN: 9789358913323

sorghum, oat and millet can be used as suitable alternatives formulated biscuits using legume and millet flour and found higher acceptability of the product.

Foxtail millet biscuit

High in fiber: Millets are a great source of dietary fiber, which can help to promote healthy digestion and prevent constipation.

Rich in minerals: Millets are a good source of essential minerals such as iron, magnesium, phosphorus, and potassium, which are important for maintaining healthy bones, muscles, and other bodily functions.

Low in fat: Millets are naturally low in fat, making them a great choice for people who are looking to reduce their overall fat intake.

Gluten-free: Most varieties of millets are gluten-free, which makes them a great option for people with celiac disease or gluten intolerance.

Low glycemic index: Millets have a low glycemic index, which means that they are digested slowly and can help to maintain stable blood sugar levels.

High in antioxidants: Millets contain high levels of antioxidants, which can help to protect against oxidative stress and reduce the risk of chronic diseases such as cancer and heart disease.

Conclusion

With the growing challenge of producing health-promoting food products, the food industries are focusing on less exploited ingredients. This article highlights the versatility and importance of foxtail millet as a food source, which has pertinent levels of all the nutritional components required. As bakery products consumed by all age group people exploring millets in bakery products is most essential and it increases the nutrient composition of the food products.

ISBN: 9789358913323

References

1. PADMA, A. AND RAJENDRAN, R., 2016, Development and Evaluation of Spirulina Incorporated Little Millet Cookies. *Madras Agricultural Journal*, **103** (4-6): 199-201.
2. SRILEKHA, K., KAMALAJA, T., MAHESWARI, K. U. AND RANI, R. N., 2019, Nutritional Composition of Little Millet Flour. *International Research Journal of Pure and Applied Chemistry*, **20** (4): 1-4.
3. SUBBULAKSHMI, B. AND MALATHI, D., 2017, Formulation of multi millet cookies and evaluate its hypoglycaemic effect in albino rats. *Journal of Crop and Weed*, **13** (3):112-116.
4. THEJASRI, V., HYMAVATHI, T. V., ROBERTS, T. P., ANUSHA, B. AND DEVI, S. S., 2017, Sensory, Physico-Chemical and Nutritional Properties of Gluten Free Biscuits Formulated with Quinoa (Chenopodium quinoa Willd.), Foxtail Millet (*Setaria italica*) and Hydrocolloids. *Int. J. Curr. Microbiol. App. Sci*, **6** (8): 1710-1721.
5. USHAKUMARI, S. R. AND MALLESHI, N. G., 2007, Small millets: Nutritional and technological advantages. Food uses of small millets and avenues for further processing and value addition, Ed. KRISHNEGOWDA, K. AND SEETHARAM, All India Coordinated Small Millets Improvement Project, ICAR, UAS, Bangalore.

ISBN: 9789358913323

6. A REVIEW ON NUTRITIONAL VALUE AND HEALTH BENEFITS OF MILLETS.

Dr. Geetha HL[1], Geetha KN[2] and Tejaswini,[3]
Assistant Professor , Department of Botany
Maharani Lakshmi Ammanni College for Women Autonomous, Bangalore

Abstract:

Millets has globally gained attention as source of food due to its increase in demand in few decades. Millets are grown in semi-arid zones of the world which can tolerate drought and are also good source of energy. Millets contains all essential nutrients such as protein, carbohydrates, fat, minerals, vitamins, and bioactive compounds. Millets possess antioxidant, anticancerous, antidiabetic, antiaging, antihypertensive, cardioprotective activities which are very helpful for mankind and presence of certain phytochemicals such as phenolic acids, flavonoids, lignin, insulin-resistant starch, and β-glucan has significant health benefits. The main aim of the review is to provide the insight of the nutritional value of millets.

Keywords: Millets, phytochemical, nutritional value, human health etc.

Introduction:

"Millets" that were called as Poor man's food has got global attention due to its nutritive value. It has become an essential dietary component to be healthy. Sorgum, Pearl millet, Finger millet (Major millets) foxtail, Little millet, Kodo, Proso and Barnyard millet (Minor millets) are different types of millets grown in India. Millets belong to family Poaceae, which are grown in many parts of India such as Rajasthan, Maharashtra, Karnataka, Andhra Pradesh, and Madhya Pradesh etc. Millets have gained domestic and international markets. Millet can adapt to different types of soil from poor to very fertile and can also tolerate certain degree of alkalinity. The best soils are alluvial, loamy and sandy soil. Millets require very less water as compared to rice and wheat and considered drought tolerant crops. Most of the millets are Kharif season crops (sown during May-June) and come to maturity during September to October. Most of these crops give good yields during Rabi season (October-March) and summer season (January-April). Millets have high nutritional and health benefits which help in managing health problems like diabetes mellitus, hyperlipidemia, etc. (Veena, 2003). The nutri-rich millets are the viable solution to reduce the rising incidences of malnutrition and metabolic disorders and can enhance the nutrition and food security of the country.

ISBN: 9789358913323

Millets are a highly nutritious crop and contain considerable amounts of vitamins and minerals. Millets are a good source of energy, dietary fiber, slowly digestible starch, and resistant starch, and thus provide sustained release of glucose (Nithiyanantham et al. 2019). Studies have revealed that compared to cereals, millets are a good source of protein- and sulphur-containing amino acids such as methionine and cysteine and also have a better fatty acid profile. Millets are rich in vitamin E and vitamin B and in minerals such as calcium, phosphorus, magnesium, manganese, potassium, and iron (Birania et al. 2020, Ashok et al. 2020).The millets provide multiple health benefits such as reducing the incidence of cancer (Kumar A et al. 2016b), obesity and diabetes(Singh V et al. 2022) , cardiovascular diseases (Kumari and Thayumanavan 1997), gastrointestinal problems (Sarita, E. S *et al* 2016), migraine, and asthma (Malik S 2015). Therefore, millets play an important role in the modern diet as a potential source of essential nutrients. Most millets are gluten free and can be used by individuals who are sensitive to gluten. (Sella durai, M et al. 2022). The aim of this review is to provide nutritional benefits of millets, to overcome malnutrition and to promote millets as our daily dietary component to lead healthier life.

Nutritional components of millet grains:

The average of nutrient composition of some millet grains is summarized in Table 1. About 7- 12g protein is present in 100g of millets, fat ranging from 1.3 to 5 g, carbohydrates 67 to 75 g which provides energy from 329 to 363 kcal hence millets are energy rich food.

Table: 1

Millets	Protein b (g)	Fat (g)	CHO (g)	Crude Fiber (g)	Energy (kcal)	Calcium (mg)	Iron (mg)	Thiamin (mg)	Niacin (mg)	Riboflavin (mg)
Sorghum	10.9	3.2	73	2.3	329	27	4.3	0.300	2.83	0.138
Pearl millet	11.0	5.0	69	2.2	363	25	3.0	0.3	2.0	0.15
Finger millet	6.0	1.5	75	3.6	336	350	5.0	0.3	1.4	0.10
Foxtail	9.9	2.5	72	10.0	351	20	4.9	0.59	0.99	0.099
Little millet	7.7	4.7	67	7.6	329	17	9.3	0.3	3.2	0.09
Kodo	11.5	1.3	74	10.4	353	35	1.7	0.15	2.0	0.09
Proso	10.6	4.0	70	12.0	364	8	2.9	0.405	4.54	0.27
Barnyard	10.29	3.06	69.95	4.25	349	30.10	3.73	0.16	3.6	0.62

*Source: Indian Food Composition Tables, NIN – 2017 and *Nutritive value of Indian foods, NIN – 2007*

Nutritional characteristics of Millets

ISBN: 9789358913323

Carbohydrates:

The carbohydrate content in sorghum is composed of starch, soluble sugar and fiber (pentasons, cellulose and hemicellulose). Sorghum is composed of amylopectin. Starch is the most abundant component while soluble sugars are low. Carbohydrate components of pearl millet grains comprise of starch, dietary fiber and soluble sugars.

Pearl millet contain amylase ranging 20-21.5% and have higher solubility than other starches (Lestieme et al., 2007). Soluble sugars are also present in the range of 1.2 to 2.6 %. Free sugars such as glucose, fructose, sucrose and raffinose are present from 1.2 to 2.5% (Jambunathan and Subramanian, 1989; Gupta and Nagar, 2010)

Finger millet is a rich source of carbohydrates and comprises of free sugars (1.04%), starch (65.5%), and non-starchy polysaccharides (Malleshi, Desikachar, & Tharanathan 1986) The carbohydrate content of finger millet is comparable to that of wheat but lower than that of polished rice. (Shobana et al. 2013). Finger millet starch comprises amylose and amylopectin.

Fox millet contains starch such as amylose and amylopectin and contain slow digesting starch.

The carbohydrate content of varies between 51.5 and 62.0 g/100 g which is lower than that of other major and minor millets (Saleh et al., 2013).

Proso millet starch consists of; amylopectin and amylose. The amylose content in proso millet ranges from 17.21% to 32.6%, (Kumari and Thayumanavan 1997). Proso millet starch has an amylose content slightly higher than maize (17-27%) (Yanez et al. 1991) and slightly lower than rice (28%) (Kumari and Thayumanavan 1997).

Proteins:

The protein content of sorghum is usually 11-13% but sometimes higher values are reported (David A. V. Dendy, 1995). Major portion of sorghum protein is prolamin (kaffirin) which has a unique feature of lowering digestibility upon cooking whereas, the millets have a better amino acid profile.

Pearl millet contains generally 9 to 13% protein. The essential amino acid profile shows more lysine, threonine, methionine and cystine in pearl millet protein than in proteins of sorghum and maize (Adeola et al., 2005). Tryptophan content is also higher in the pearl millet (Hoseney et al., 1994). Serna Saldivar et al 1994 have reported that the lysine content of the protein reported in pearl millet grain ranges from 1.9 to 3.9 g per 100 g protein.

Prolamins are the major fractions of finger millet protein (Virupaksha, Ramachandra, & Nagaraju, 1975). Albumin and globulin fractions contain several essential amino acids, while the prolamin

ISBN: 9789358913323

fraction contains higher proportion of glutamic acid, proline, valine, isoleucine, leucine, and phenylalanine but low lysine, arginine, and glycine. Finger millet contains higher levels of sulfur containing amino acids, namely, methionine and cystine, compared to milled rice (Shobana et al 2013).

The protein content in fox millet is higher among millets. Glutamic acid, leucine, alanine, and proline, tryptophan were the main amino acids found in fox tail millet (Hariprasanna 2016)

Kodo millet is also rich in essential amino acids, like lysine, threonine, valine, sulphur containing amino acids and the ratio of leucine to isoleucine is about 2.0 (Ravindran, 1992) , but it is deficient in tryptophan amino acid.

The limiting amino acid of proso protein is lysine whose content ranges from 1.4 to 4.3% (Ravindran 1992; Dendy 1995; FAO 1995; Kalinová and Moudrý 2006). The lysine level is higher than wheat (Kalinová and Moudrý 2006). According to Geervani and Eggum (1989a), the lysine content of proso millet is low compared to other millets but according to FAO (1995), the lysine content in proso millet is the highest from minor millet The protein of proso millet can be also marginal in threonine (Dendy 1995).The complex is rich, especially in leucine (Ravindran 1992; Kalinová and Moudrý 2006). Glutamic acid, alanine, proline and asparatic acid are the major non-essential constituents of proso millet protein (Ravindran 1992; Kalinová and Moudrý 2006).

Fibre:

Sorghum is a good source of fibre, mainly the insoluble (86.2%) fibre. The insoluble dietary fibre of sorghum and millet may decrease transit time and prevent gastrointestinal problems.

Pearl millet contains about 5 g per 100 g of insoluble and 3 g per 100 g soluble dietary fibres (Nandini and Salimath 2001).The fibres together with phytates chelate minerals and form fibre–phytate–mineral complexes.

The finger millet dietary content (11.5%) is much higher than the fiber content all other millets such as foxtail, little, kodo, and barnyard millet. However, the dietary fiber content of finger millet is comparable to that of pearl millet and wheat.

The essential amino acids present in barnyard millet are lysine, methionine, threonine, isoleucine, leucine, histidine, tryptophan and the non-essential amino acids are aspartic acid, glutamic acid, arginine, alanine, cysteine, glycine, and proline (Muthamilasaran et al., 2015)

Kodo Millet contains high amount of crude fiber (9%) as compared to wheat (1.2%)

ISBN: 9789358913323

Lipids:

Sorghum contain lipids such as phytosterols, policosanols, unsaturated fatty acids, aldehydes and steryl/wax esters and a series of studies have shown that Sorghum lipids exert health-benefiting effects on cholesterol metabolism and intestinal microbiota. (Lee et al. 2011).

The lipid content in pearl millet grain ranges from 1.5 to 6.8% which is higher than all other millets (Taylor, 2004). The fatty acid such as palmitic, stearic and linolenic acids present in higher concentration and oleic and linoleic acids are present in lower concentration (Adeola et al., 2005). About 75% of the fatty acids in pearl millet are unsaturated and linoleic acid is present in high concentration of 46.3%.

About 1.85–2.10% of total lipids is present in seven breeding varieties of finger millet (Mahadevappa and Raina 1978). Finger millet lipids consist of 70–72% neutral lipids mainly triglycerides and traces of sterols, 10–12% of glycolipids, and 5–6% of phospholipids, lipids also contain 46–62% oleic acid, 8–27% linoleic acid, 20–35% palmitic acid, and traces of linolenic acid.

The lipid content of foxtail millet exceeds 4%, 85% of which is comprised of unsaturated fatty acids, which is higher than in most other cereal crops, such as corn and rice. In foxtail millet bran oil linoleic (45.7%), oleic (24.7%), palmitic (16.7%) and stearic acids (8.2%) were identified by S. Liang et al (2010).

In dehulled grains of proso millet Lipids are relatively minor constituents in cereal grains but lipid content ranges from 3.5 to 6.7% (Jones et al. 1970; Kalinová 2002).In proso millet the total lipids of is 62.2, 27.8 and 10.0% (Sridhar and Lakshminarayana 1994). In the free lipids, hydrocarbons, sterol esters, triglycerides, diglycerides, and fatty acids are present. In the bound lipids, monogalactosyl diglycerides, digalactosyl diglycerides, phosphatidyl ethanolamine, phosphatidyl serine, and phosphatidyl choline are present (Lorenz and Hwang 1986). The lipids consist from 81 to 88% of non-polar lipids (their main constituents are triacylgylcerols, 81%; free fatty acids, 4%; free sterols, 7.8%), from 8 to 14% of glycolipids (their main constituents are monogalactosyldiglycerides: 40.4%) and from 2 to 5% of phospholipids (their main constituents are phosphatidylcholine: 36.8%) (Dendy 1995)

Vitamins and minerals:

Sorghum contains various types of vitamins and minerals. Vitamins B-complex such as pyridoxine, riboflavin and thiamine, and fat-soluble vitamins including A, D, E & K. are present in sorghum (USDA, U. 2018). Mineral source such as phosphorus, potassium, iron and zinc are also present in

ISBN: 9789358913323

sorghum (Afify et al). The iron content in sorghum varies from 6.6% to 15.7% and zinc ranges from 9.7% to 17.1% (Kumar et al. 2013).

Pearl millet grain is an important source of thiamine, niacin and riboflavin (Taylor, 2004). Pearl millet grains contain 0.38mg of thiamine, 0.21 mg riboflavin, and 2.8 mg of niacin (Hulse et al., 1980). Due to its high oil content, pearl millet is also a good source of lipid-soluble vitamin E. Its content in pearl millet is about 23 mg/100 g (Taylor, 2004). Pearl millet is also a good source of the lipid-soluble vitamin A. Pearl millet is a good source of minerals, containing appreciable amounts of calcium, phosphorus, magnesium, and iron (Burton et al., 1992).

Finger millet is rich in calcium (344 mg %) compared to other cereals and contains 283 mg% phosphorus, 3.9 mg% iron (Gopalan et al., 2009), and many other trace elements and vitamins. Potassium content of finger millet is also high (408 mg %) compared to other cereals and millets. The phytic acid content of finger millet was lower than the levels present in common (proso) millet and foxtail millet and the values were in the range of 0.45–0.49 g% for different varieties of finger millet. The oxalate contents of finger millet were in the range of 29–30 mg% (Ravindran, 1991)

Among all millets Foxtail millet contains highest content of zinc (4.1 mg/100 g) and is also a good source of iron (2.7 mg/100 g) (Chandel 2014) and also contain copper.

Kodo millets are rich in vitamin B3, vitamin B6 and folic acid as well as minerals such as calcium, potassium, magnesium and zinc.

The dehulled grains of proso millet are rich in vitamin B1 – thiamine (0.42-0.80 mg/100 g), B2 – riboflavin (0.22- 0.40 mg/100 g), B3 – niacin (1.55-3.7 mg/100 g), B6 – pyridoxin (0.52-0.80 mg/100 g) and E – tocopherol (0.1-2.60 mg/100 g) (Dendy 1995). The level of vitamins B1 and B2 is twice as high as rice, wheat or barley (Murzamadieva 1979).

Health benefits of Millets:

Millets as diet component in our food has many health benefits.

Reduces cardiovascular disease:

Millets are rich sources of magnesium, help in reducing blood pressure and risk of heart strokes especially in atherosclerosis. Also, the potassium present in millets helps in keeping blood pressure low by acting as a vasodilator and help to reduce cardiovascular risk.

ISBN: 9789358913323

Diabetes Mellitus:

Finger millet based diets have shown lower glycemic response due to high fiber content and also alpha amylase inhibition properties which are known to reduce starch digestibility and absorption (Kumari and Sumathi, 2002).

Gastrointestinal Disorders:

Fiber content in millets helps in eliminating disorders like constipation, excess gas, bloating and cramping. An immune mediated enteropathic disease called celiac disease which is usually triggered by the ingestion of gluten in susceptible individuals (Catassi and Fasano, 2008). Hence millets which are gluten free can be used in the diet.

Cancer:

Millet grains are rich in phenolic acids, tannins, and phytate (Thompson, 1993). These nutrients reduce the risk for colon and breast cancer in animals (Graf and Eaton, 1990). Recent research has revealed that fiber as one of the best and easiest ways to prevent the onset of breast cancer in women. They can reduce their chances of breast cancer by more than 50% by eating more than 30 gm of fiber every day.

Change in life style and food habit have impact on human health. “Rich people's diseases” like obesity, high blood pressure, cardiovascular disease and diabetes have arisen along with the change of dietary habit. Therefore, a large number of high-value novel foods, known as functional foods or nutraceuticals appear in our daily life (Arvanitoyannis and Van Houwelingen-Koukaliaroglou, 2005). Healthy supplements in our daily food is very essential.

A study conducted on 9- to 10-year-old girls showed that replacement of rice with finger millet diet apart from maintaining the positive nitrogen balance also improved calcium retention (Joseph, Kurien, Swaminathan, & Subrahmanyan, 1959). Being rich source of calcium and iron, and the fact that the bioavailability can be improved by simple processing such as germination and fermentation, it should be considered as a good supplement for children and adolescents for improving bone health and haemoglobin.

Nutrition plays a significant role in controlling communicable and non-communicable diseases in humans. Malnutrition, the worst form of the non-communicable disease, is an important risk factor, for emerging chronic diseases at a later date. Malnutrition occurs mainly in children

consequent to the inadequate supply of the recommended dietary allowance (RDA). The RDA is the amount of nutrients required to prevent diseases. Pearl millet is a rich source of many health-related components such as iron, zinc, folic acid and β-carotene could be used for combating

ISBN: 9789358913323

malnutrition arising out of deficiency of minerals. To enhance iron and zinc bioaccessibility in pearl millet, a proper understanding of the effect of various processing technologies on the reduction of inhibitory factors is required.

Conclusion:

Millets as a source of food is a boon to mankind. Millets has a rich source of all major essential nutrients required to maintain healthy life. Millet flour can be an alternative to Maida flour. Millets should be a part of our daily food supplement as it reduces the intake of synthetic chemical substitutes which are recommended to take during vitamin and mineral deficiency. Millets Many value added products can be prepared by Millets which are healthy and snacky. The biggest threat of any country which is malnutrition in children and millets can combat malnutrition. Millets should also be included in the meals provided to the children in school by government. Awareness about millets nutritional value and its use is necessary.

References:

1. Adeola O and Orban JI (2005). Chemical composition and nutrient digestibility of Pearl millet (Pennisetum glacum L.) fed to growing pigs. Journal of Cereal Science 22 174-184.
2. Afify, A. E. M. M.; El-BELTAGI, H. S.; Abd El-Salam, S. M.; Omran, A. A. Oil and Fatty Acid Contents of White Sorghum Varieties under Soaking, Cooking, Germination and Fermentation Processing for Improving Cereal Quality. Not. Bot. Horti. Agrobot. Cluj. Napoca. 2012, 40(1), 86–92.
3. Arvanitoyannis, I. S., & Van Houwelingen-Koukaliaroglou, M. (2005). Functional foods: a survey of health claims, pros and cons, and current legislation. Critical reviews in food science and nutrition, 45(5), 385-404.
4. Ashoka, P., Bandla Gangaiah and Sunitha, N. H. (2020). Millets-Foods of Twenty First Century.Int.J.Curr.Microbiol.App.Sci. 9(12): 2404-2410.
5. Birania S., Rohilla P., Kumar R., Kumar N. (2020), Post-harvest processing of millets: A review on value added products. Int. J. Chem. Stud. 8:1824–1829.
6. Burton GW, Wallace At and Rachie KO(1992). Chemical composition and nutritive value of Pearl Millet (Pennisetum Typhoides) Grain. Crop Science12: 187-188.
7. Catassi, C., & Fasano, A. (2008). Celiac disease. Gluten-free cereal products and beverages, 1-I.
8. Chandel G, Kumar M, Dubey M, Kumar M. (2014) Nutritional properties of minor millets: neglected cereals with potentials to combat malnutrition. Curr Sci.;107(7):1109–11.

ISBN: 9789358913323

9. David A. V. Dendy (1995). Sorghum and Millets Chemistry and Technology 406 pp. USA, St. Paul,Minnesota, American Association of Cereal Chemists, Inc.
10. FAO (1995) Sorghum and Millets in Human Nutrition, Food and AgricultureOrganization of The United Nations, Rome, 184 pp
11. Gupta, V., & Nagar, R. (2010). Effect of cooking, fermentation, dehulling and utensils on antioxidants present in pearl millet rabadi—a traditional fermented food. Journal of food science and technology, 47, 73-76.
12. Gromova Z (1991) Buckwheat in human diet. In: Anonymous (Ed) Common Buckwheat – the Important Source of Biofood stuffsVULP, Nitra, pp 75-88.
13. Geervani, P., & Eggum, B. O. (1989). Nutrient composition and protein quality of minor millets. Plant Foods for Human Nutrition, 39, 201-208.
14. Graf E, Eaton JW. Antioxidant functions of phytic acid. Free Radic Biol Med. 1990;8(1):61–69.
15. Gopalan, C., Rama Sastri, B. V., & Balasubramanian, S. C. (2009). Nutritive value of Indian foods. Hyderabad, India: National Institute of Nutrition, Indian Council of Medical Research.
16. Hariprasanna K. Foxtail millet, Setaria italica (L.) P. Beauv. In: Patil JV, editor. Millets and sorghum: biology and genetic improvement, 1 st Edn. UK: John Wiley & Sons Ltd. ISBN 978-1-119-12305-7.
17. Hossney A, Singh J, Faubian JN and Hanna RC (1994). Studies on odour generation in ground pearlmillet. Cereal Food World 35 838-840.
18. Hulse JH, Laing EM and Pearson OE (1980). Sorghum and the Millets: Their Composition and Nutritive Value, (USA, New York: Academic Press) 1–997
19. IIMR. Nutritional and Health Benefits of Millets; Indian Institute of Millets Research: Hyderabad, India; ICAR: New Delhi, India, 2017
20. Jambunathan R and Subaramanian V (1989). Grain quality and utilization of sorghum and pearl millet. In Biotechnology in tropical crop improvement, Proceedings of the International Biotechnology Workshop, ICRISAT Center, India, 133-139.
21. Joseph, K., Kurien, P. P., Swaminathan, M., & Subrahmanyan, V. (1959). The metabolism of nitrogen, calcium and phosphorus in undernourished children: 5.* The effect of partial or complete replacement of rice in poor vegetarian diets by ragi (Eleusine coracana) on the metabolism of nitrogen, calcium and phosphorus. British Journal of Nutrition, 13(2), 213-218.
22. Kalinova, J., & Moudry, J. (2006). Content and quality of protein in proso millet (Panicum miliaceum L.) varieties. *Plant Foods for Human Nutrition*, *61*(1), 43-47.

ISBN: 9789358913323

23. Kumar, A., Metwal, M., Kaur, S., Gupta, A. K., Puranik, S., Singh, S., et al. (2016b). Nutraceutical value of finger millet [Eleusine coracana (L.) Gaertn.], and their improvement using omics approaches. Front. Plant Sci. 7:934
24. Kumari SK, Thayumanavan B (1997). Comparative study of resistant starch from minor millets on intestinal responses, blood glucose, serum cholesterol and triglycerides in rats. Journal Science of Food and Agriculture 75: 296–302.
25. Kumar, A. A.; Reddy, B. V.; Ramaiah, B.; Sahrawat, K. L.; Pfeiffer, W. H. Gene Effects and Heterosis for Grain Iron and Zinc Concentration in Sorghum [Sorghum Bicolor (L.) Moench]. Field Crops. Res. 2013, 146, 86–95.
26. Lee, B. H., Weller, C. L., Cuppett, S. L., Carr, T. P., Walter, J., Martínez, I., & Schlegel, V. L. (2011). Grain sorghum lipids: Extraction, characterization, and health potential. In Advances in cereal science: implications to food processing and health promotion (pp. 149-170). American Chemical Society.
27. Lestienne I, Buisson M, Lullien-Pellerin V, Picq C and Treche S (2007). Losses of nutrients and antinutritional factors during abrasive decortication of two pearl millet cultivars (Pennisetum glaucum). Food Chemistry 100(4) 1316–23.
28. Liang, S., Yang, G., & Ma, Y. (2010). Chemical characteristics and fatty acid profile of foxtail millet bran oil. Journal of the american oil chemists' society, 87(1), 63-67.
29. Malik, S. (2015). Pearl millet-nutritional value and medicinal uses. International Journal of Advance Research and Innovative Ideas in Education, 1(3), 414-418.
30. Mahadevappa, V. G., & Raina, P. L. (1978). Lipid profile and fatty acid composition of finger millet (Eleusine coracana). Journal of Food Science and Technology, 15(3), 100–102.
31. Malleshi, N. G., Desikachar, H. S. R., & Tharanathan, R. N. (1986). Free sugars and nonstarchy polysaccharides of finger millet (Eleusine coracana), pearl millet (Pennisetum typhoideum), foxtail millet (Setaria italica) and their malts. Food Chemistry, 20, 253–261.
32. Murzamadieva MA (1979) Proso millet . Kolos, Alma-ata, 80 pp
33. Muthamilarasan M, Prasad M. Advances in Setariagenomics for genetic improvement of cereals and bioenergy grasses. Theoretical and applied genetics. 2015 ,128(1):1-4
34. Nandini CD, Salimath PV. Carbohydrate composition of wheat, wheat bran, sorghum, and bajra with good chapatti/roti (Indian flatbread) making quality. Food Chem. 2001; 73:197–203.
35. Nithiyanantham S., Kalaiselvi P., Mahomoodally M.F., Zengin G., Abirami A., Srinivasan G. Nutritional and functional roles of millets—A review. *J. Food Biochem.* 2019; 43:1–10.
36. NIN. Indian Food Compostion Tables; IIMR (Ministry of Health and Family Welfare, GoI): Hyderabad, India, 2017.

ISBN: 9789358913323

37. Ravindran, G. (1991). Studies on millets: Proximate composition, mineral composition, and phytate and oxalate contents. Food Chemistry, 39, 99–107
38. Ravindran, G. (1992). Seed protein of millets: amino acid composition, proteinase inhibitors and in-vitro protein digestibility. Food chemistry, 44(1), 13-17.
39. Saleh, A., Zhang, Q., Chen, J., and Shen, Q. (2013). Millet grains: nutritional quality, processing, and potential health benefits. Compr. Rev. Food Sci. Food Saf. 12, 281–295.
40. Sarita, E. S., & Singh, E. (2016). Potential of millets: nutrients composition and health benefits. Journal of Scientific and Innovative Research, 5(2), 46-50.
41. Selladurai, M., Pulivarthi, M. K., Raj, A. S., Iftikhar, M., Prasad, P. V., & Siliveru, K. (2022). Considerations for gluten free foods-pearl and finger millet processing and market demand. Grain & Oil Science and Technology.
42. Serna-Saldivar SO, Clegg C and Rooney LW (1994). Effects of parboiling and decortication on the nutritional value of sorghum (Sorghum bicolor L. Moench) and pearl millet (Pennisetum glaucum L).Journal of Cereal Science 19(l) 83-89.
43. S. Liang, G. Yang, Y. Ma, Chemical characteristics and fatty acid profile of foxtail millet bran oil, J. Am. Oil. Chem. Soc. 87 (2010) 63-67.
44. Shobana, S., Krishnaswamy, K., Sudha, V., Malleshi, N. G., Anjana, R. M., Palaniappan, L., & Mohan, V. (2013). Finger millet (Ragi, Eleusine coracana L.): a review of its nutritional properties, processing, and plausible health benefits. Advances in food and nutrition research, 69, 1-39.
45. Singh, V., Lee, G., Son, H., Amani, S., Baunthiyal, M., & Shin, J. H. (2022). Anti-diabetic prospects of dietary bio-actives of millets and the significance of the gut microbiota: A case of finger millet. Frontiers in Nutrition, 9.
46. Taylor JRN (2004). Millet Pearl encyclopedia of grain sciences. 2: 253-261.
47. Thompson LV. Potential health benefits and problems associated with antinutrients in foods. Food Res Int. 1993;26:131–149.
48. USDA, U. (2018). National nutrient database for standard reference, Legacy Release. United States Department of Agriculture–Agricultural Research Service.
49. Veena B (2003). Nutritional, functional and utilization studies on barnyard millet. M. Science Thesis, University of Agricultural Sciences, Dharwad (Karnataka), India.
50. Virupaksha, T. K., Ramachandra, G., & Nagaraju, D. (1975). Seed proteins of finger millet and their amino acid composition. Journal of the Science of Food and Agriculture, 26, 1237–1246.
51. Yanez, G. A., Walker, C. E., & Nelson, L. A. (1991). Some chemical and physical properties of proso millet (Panicum milliaceum) starch. Journal of Cereal Science, 13(3), 299-305

ISBN: 9789358913323

7. AN OVERVIEW OF MILLETS – A FUTURE FEED FOR NOURISHMENT

Priyanka G.M., Sharanya G., Kavya B. & M. Reema Kumari

Dept. of Botany, Maharani Lakshmi Ammanni College for Women, Autonomous, Bengaluru

INTRODUCTION

The name “Millet” has been derived from the word “mil or thousand” referring to the large number of grains that can be produced from a single seed. (Singh J.P. *et al*.) Millets, popularly known as "Nutri-cereals," as it enables in nutritional security sustainably and also climate-resilient crops and yield better than wheat and rice in terms of marginal growing conditions and have a superior nutritional profile. (Kumar A *et al*., 2018)

Government of India celebrated the year 2018 as the **National Year of Millets** to augment the production and consumption of millets and to encourage and promote the millet production. The Food and Agriculture Organization of the United Nations (FAO) has declared 2023 as the **International Year of Millets**. (Kumar P *et al*., 2009)

While it is becoming evident that millets, especially the small millets, played an important role in some early farming societies, the extent of millet use is still not adequately understood. What is needed at this point is to first construct a "cultural" history of millet use across the globe. This might lead to an alternative history of agriculture from the point of view of a crop of the poor, or one that focuses on minor or secondary crops. And secondly, there is need to bring together people who study millets in prehistory. At such a gathering standard for the collection, analysis, identification and interpretation of millets could be developed. These two objectives would help set the foundation for millet studies of the future. (Weber S.A. and Fuller D.Q., 2008)

Being a key source of animal food, millet production has been sharply increasing over the last few years in order to cope with the dietary requirements of the ever-increasing world population. Analyzing literature reviews, it is evident that the incorporation of millet and its constituents into foodstuffs could be useful against undernourishment and several other health diseases. Additionally, this review provides crucial information about the beneficial features of millet, which can serve as a benchmark of guidelines for industry, consumers, researchers, and nutritionists (Sabuz A.A. et al., 2023).

ISBN: 9789358913323

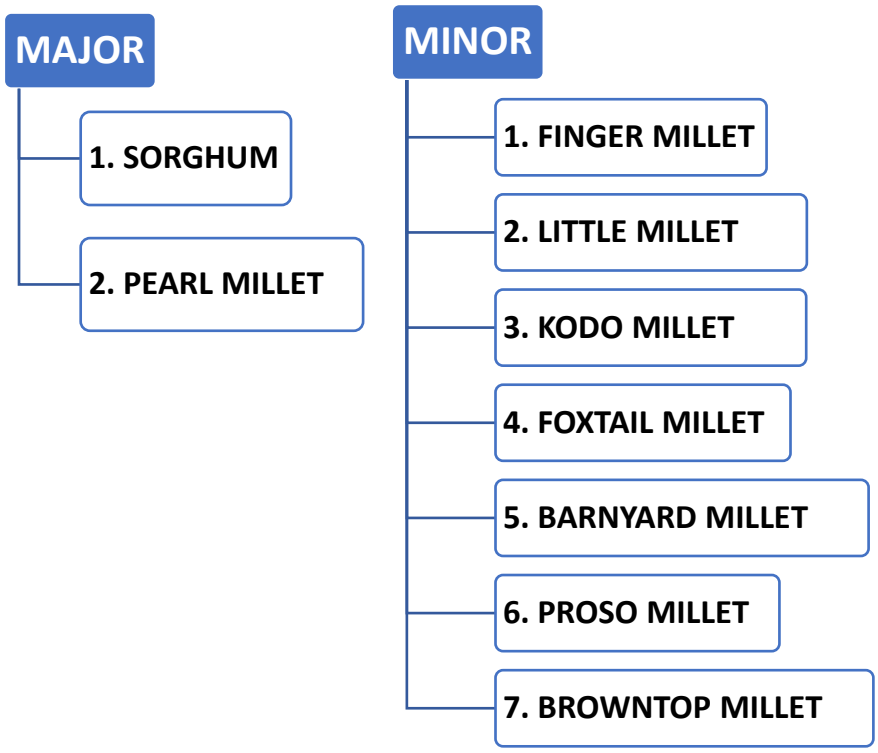
ORIGIN AND HISTORY

In India, millets have been mentioned in some of the oldest Yajurveda texts, identifying foxtail millet (*priyangava*), Barnyard millet (*aanava*) and black finger millet (*shyaamaka*), thus indicating that millet consumption was very common, pre-dating to the Indian Bronze Age (4,500 BC). (ICRISAT)

Archaeobotanical studies of plant and grain remains obtained from archaeological sites during the past two decades have resulted in an almost continuous history of millet cultivation in India. Various types of millets have been reported from the pre-Harappan culture at Rohira, the Late Harappan culture at Hulas in western Uttar Pradesh, in the same context at several sites in Guarajat (Rangpur, Surkodta, Rojdi) and in the Neolithic levels at Hallur (Karnataka), besides Pirak in Pakistan. These grains were grown in the Chalcolitihic culture at Ahar (south-eastern Rajasthan) and at Paunar in northern Maharasthra.

Among the Neolithic cultures of South India two sites located in Karnataka have furnished evidence of cultivation of millet. These are Hallur and Tekkakota. The earliest report of a millet in India is the presence of *Eleusine coracana* at the former site dating to approximately 2300 B.C. (Vishnu Mittre 1971). In the recent excavations of Oriyo Timbo in the Shavnager district of Gujarat state, 77% of seeds were found to be millets comprising *Panicum*, *Setaria* spp. (foxtail millet) and *Eleusine coracana* (finger millet or ragi). (Singh P, 1996)

CLASSIFICATION OF MILLETS



ISBN: 9789358913323

HEALTH BENEFITS OF MILLETS

Millets are nutritionally superior as their grains contain high amount of proteins, essential amino acids, minerals, and vitamins. Almost all the millets are used for human consumption in most of the developing countries, but their use has been primarily restricted to animal feed in developed countries. Millets are nutritionally comparable to major cereals for carbohydrates/ energy, and serve as good source of protein, micronutrients and phytochemicals.

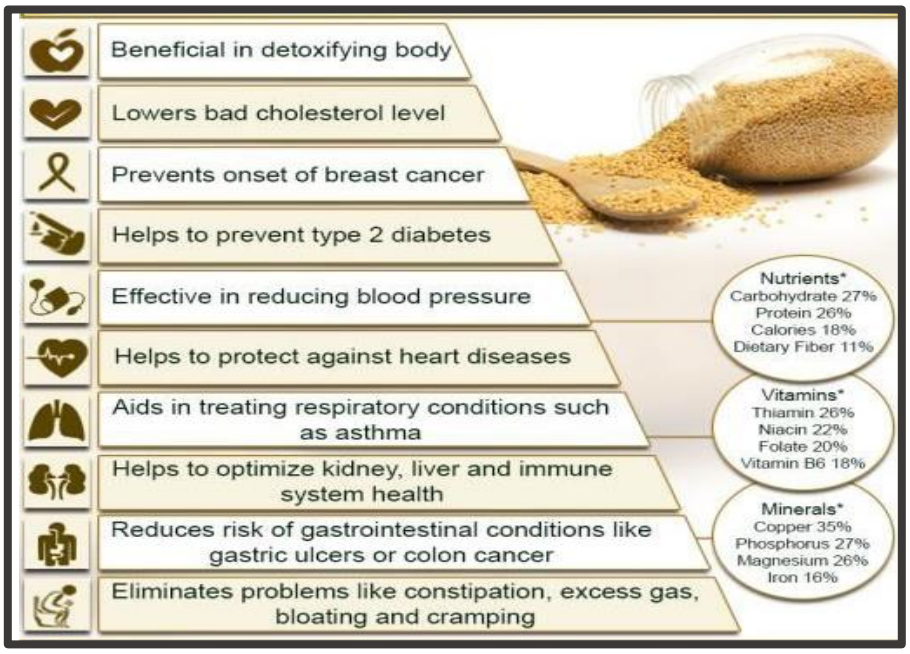
Millets contain more dietary fibre and higher amalyse inhibitory activity and thus millets-based foods are low in glycemic index. This is very much important in delaying and management of diabetes (hyperglacemia). It is well recognized that, the incidence of diabetes mellitus and gastro-intestinal tract related disorders are minimal among the population using these grains as staple food. All millets have proven to possess excellent anti-hyperglycemic activity. The dietary fibre, due to higher viscosity and water holding capacity, plays a key role in reduction of blood glucose level as well as insulin response. It also lowers the level of cholesterol and decreases the risk of bowel disorders. Millets contribute to antioxidant activity with phytates, polyphenols, tannins, anthocyanins, phytosterols and pinacosanols present in it having important role in aging and metabolic diseases. The high levels of tryptophan in millets produce serotonin, which is calming to our moods. Niacin in millet can help lower cholesterol. Millet consumption decreases triglycerides and C-reactive protein, thereby preventing cardiovascular disease.

The presence of good amounts of phospholipids consisting both lecithin and cephalins, in Pearl millet plays a great role in general metabolism, being concentrated in brain are useful in brain function, behavioural disorders and stress. Finger millet proteins are unique because of the sulphur rich amino acid contents. Kodo millet is rich in B vitamins especially niacin, pyridoxine and folic acid as well as the minerals such as calcium, iron, potassium, magnesium and zinc. Barnyard millet is the richest source of crude fiber and iron. (Bhat B.V. *et al*., 2019)

ISBN: 9789358913323

NUTRIENT COMPOSITION OF MILLETS

MILLETS	Carbohydrates (g)	Protein (g)	Fat (g)	Energy (Kcal)	Crude fibre (g)	Mineral Matter (g)	Ca (mg)	P (mg)	Fe (mg)
Small millets									
FINGER MILLET	72.0	7.3	1.3	328	3.6	2.7	344	283	3.9
KODO MILLET	65.9	8.3	1.4	309	9.0	2.6	27	188	0.5
PROSO MILLET	70.4	12.5	1.1	341	2.2	1.9	14	206	0.8
FOXTAIL MILLET	60.9	12.3	4.3	331	8.0	3.3	31	290	2.8
LITTLE MILLET	67.0	7.7	4.7	341	7.6	1.5	17	220	9.3
BARNYARD MILLET	65.5	6.2	2.2	307	9.8	4.4	20	280	5.0
Major Millets									
SORGHUM	72.6	10.4	1.9	349	1.6	1.6	25	222	4.1
PEARL MILLET	67.5	11.6	5.0	361	1.2	2.3	42	296	8.0
CEREALS									
Wheat	71.2	11.8	1.5	346	1.2	1.5	41	306	5.3
Rice	78.2	6.8	0.5	345	0.2	0.6	10	160	0.7



MILLETS ARE SMART FOODS

In this era of explosion of availability of super foods, the millets have a unique standing. They are easy and friendly to cultivate, are nearly organic and have good nutritional content. Therefore, the following attributes are aptly applied to millets.

a. **Good for the consumer**: they can help overcome some of the biggest nutritional and health problems (iron, zinc, folic acid, calcium, diabetes and more);

b. **Good for the planet**: they have a low water footprint, can survive in the hottest driest climates and will be important in coping with climate change, and more;

ISBN: 9789358913323

c. **Good for the farmer**: can increase yields up to 3 fold, have multiple uses (food, fodder, fuel), and are typically the last crop standing in times of drought being a good risk management strategy for farmers. (The Story of Millets)

MILLETS OF INDIA STATE-WISE

CLIMATE RESILIENT TRAITS OF MILLETS

Pearl millet	80-95	Highly resilient to heat and drought, come up in very poor soils, but responsive to high input management
Sorghum	100-125	Drought tolerant, excellent recovery mechanism from stresses, highly adapted to wide range of soils, altitudes and temperatures, responsive to high input management
Finger millet	90-130	Moderately resistant to heat, drought and humidity, adapted to wide altitude range
Foxtail millet	70-120	Adapted to low rainfall, high altitude
Kodo millet	100-140	Long duration, but very hardy, needs little rainfall, comes up in very poor soils, good response to improved management
Barnyard millet	45-60	Very short duration, not limited by moisture, high altitude adapted
Little millet	70-110	Adapted to low rainfall and poor soils- famine food; withstand waterlogging to some extent
Proso millet	60-90	Short duration, low rainfall, high altitude adapted
Fonio	75-120	Shorter duration, Adapted to poorly fertile sandy and stony soils, low rainfall
Tef	60-120	Short duration, drought and flood tolerant, high altitude adapted, fit in diverse cropping systems
Brown top millet	60-80	Short duration, adapted to poor soils with less rainfall

EXPORT

India is the fifth largest exporters of millets in the world. In 2020-21, India exported millets worth $26.97 million against $28.5 million in 2019-20. The top three importers of millets from India in 2020-21 were Nepal ($6.09 million), the UAE ($4.84 million) and Saudi Arabia ($3.84 million).

ISBN: 9789358913323

In Assam, millets grown area covered around 6602 hectares with production of around 4447 tonnes and productivity is 674kg/ha during the year 2015-16. Total consumption of small millets in Assam is 18.82 kg/ha/m. Among different districts of Assam, Nagaon covers highest area of around 1586 ha followed by Bongaigaon (1084 ha) and Dhubri (677ha) whereas the production is highest in Dhubri district (963 tonnes) followed by Nagaon (714 tonnes) and Bongaigaon (626 tonnes). (Upadhyay V)

Pearl millet is grown in about 7.1 million hectares yielding 10.3 million tons, followed by sorghum (5.7 m ha, yielding 4.4 m ton) and finger millet (1.1 m ha, yielding 1.82 m ton) and other millets (0.7 m ha yielding 0.4 m ton). Among the states, maximum area in Rajasthan (5 m ha; 87% under pearl millet) followed by Maharashtra (4 m ha, 75% under sorghum) and Karnataka (2 m ha, 54% under sorghum, 32% under finger millet). (The Story of Millets)

PROCESSING OF MILLETS

The outer tough seed coat of millets, characteristic flavour, cultural attachments and non-availability of processed millet products are limiting factors unlike rice or wheat. The farmers are getting very less price (Rs.15-20/kg) to their un- processed produce compared to processed one (Rs.80-100/kg). Unfortunately, there is no well-proven industrial process available for making white products from coloured small millets satisfactory.

PRIMARY PROCESSING METHODS

1. **De-cortication**: Partial removal of outer layer of the millet grain. It is accomplished by hand pounding and using rice de-hulling or other abrasive de- hullers.
2. **Pounding**: Traditionally, dry, moistened or wet grain is pounded with a wooden pestle in a wooden or stone mortar.
3. **De-hulling**: On de-hulling, phytin phosphorus decreased by 12% in proso millet, 39% in little millet, 25% in kodo millet and 23% in barnyard millet.
4. **Parboiling**: Parboiling is basically the process of partial cooking of grain along with husk or bran. The raw grain is briefly steamed. The resulted product is dried, de-husked and decorticated.
5. **Milling**: Milling is the process of separating bran and germ from the starchy endosperm so that the endosperm can be ground into flour and rawa using different types of sieves in a hammer mill. (Upadhyay V.)

MILLET IN THE INDUSTRY

Millets have good grain qualities suitable for processing. Processing of the grain for many ends uses involves primary (wetting, dehulling and milling) and secondary (fermentation, malting, extrusion, glaking, popping and roasting) operations. Being a staple and consumed at household

ISBN: 9789358913323

levels, processing must be considered at both traditional and industrial levels, involving small, medium and large-scale. Dehulling is not favourable to millets due to their small grain's sizes. In addition, dehulling causes nutrients loss. All the Millets can be milled by hand grinding (household level) or machine milling (cottage, small-to-medium scale service and large scale industrial). Millet and sorghum malt production is a traditional practice in Africa, where malt is used in lactic acid- and alcoholic-fermented beverages and infant food production. Traditional malting processes in many developing countries involve three main operations: soaking, germination, and drying. The duration and conditions of each operation are highly variable, resulting in highly variable malt and derived product quality. The emerging principal uses of millets as an industrial raw material include production of biscuits and confectionery, beverages, weaning foods and beer. Grits, flour, and meals from cereals such as millet, sorghum, and corn are now common items in the market. Soft biscuits and cookies are being made using sorghum, maize and wheat composites, while cakes and non-wheat breads have become a subject of increasing scientific and technological enquiry, showing encouraging results. In the infant weaning food sector, in spite of unlimited potential, progress has been slow, as the installed capacity for industrial malting is limited. Many brands of beer in the underdeveloped countries market have substantial content of local cereal such as millet to reduce the cost of imported barley. The industries are confronted with a number of problems which tend to diminish product qualities and affect overall utilization. For instance, in the non-alcoholic beverage and weaning food sectors, storage quality of the grain, nutritional losses after processing, high cost of imported equipment and variation among cultivars are some of the problems militating against improved utilization of millet in the developing countries. In a weaning process there is always the need to introduce soft, easily swallowed foods to supplement the infant's feeding early in life (Amadou I. *et al.*, 2013).

UTILIZATION OF MILLETS

In India, millets are traditionally consumed as staple foods in the Indian diet. Some typical dishes of millets in India are Jowar (sorghum) roti in Maharashtra, parts of Karnataka, Madhya Pradesh, Uttar Pradesh and Rajasthan; bajra (pearl millet) roti in Punjab, Haryana, parts of Uttar Pradesh, Rajasthan and Tamil Nadu, and ragi (finger millet) mudde in Karnataka, parts of Tamil Nadu and Andhra Pradesh. Barnyard and little millet found place for niche use, as a bhagar food, consumed during fasting.

Pearl millet is boiled to make an Indian porridge called Kambam Choru in Tamil Nadu. In Uttarakhand, finger millet is eaten as rotis, barnyard millet as paleu or chencha, a savoury porridge cooked in buttermilk. Zan is the most popular porridge recipe of Monpa tribes of Arunachal Pradesh made from finger millet and vegetables. The dehusked grain of small millets is cooked like rice and

ISBN: 9789358913323

eaten. It is also made into flour, used for making puddings or cakes. Another method is to cook cracked grains with vegetables and spices to prepare a food similar to curried rice. Foxtail millet grain is usually cooked whole like rice (millet rice) or made into meal. It is also consumed as stiff porridge called sargati, or as leavened bread known as roti, after the de-hulled grain has been milled into flour. Other food products are pudding, breads, cakes, chips, rolls, noodles, etc. Malting of finger millet for food uses is in practice from time immemorial in southern India. It has superior malting properties and the malt has acceptable taste, very good aroma and shelf life. Traditional foods prepared from barnyard and other millets such as idli, dosa and muruku are very popular in parts of southern India. Sorghum and millets are used for developing various value-added products like biscuits, sweets, vermicelli, ready mixes and multi-grain atta. In some regions minor millets remain cultivated only on a small scale but are culturally important for food stuffs, such as ritual breads made from brown top millet in restricted districts of South India. (The Story of Millets)

FALL OF MILLETS

Traditionally, millets were produced and consumed extensively in the country and had almost equal area coverage to rice and wheat. However, the post- green revolution period witnessed a drastic decline in the area under cultivation of nutri-cereals by 41.65 percent between 1950–51 and 2018–19, albeit with their diverse uses and benefit's. The main reasons reported for this decline are; low remuneration as compared to other food crops, lack of input subsidies and price incentives, subsidized supply of fine cereals through the Public Distribution System (PDS), change in consumer preference due to difficulty in processing and low social status attached to millets. (ICAR, 2021)

Millets have been discarded as being too primitive to be used, forgetting the roots. These changes, coupled with state policies that favour rice and wheat, have led to a sharp decline in millet production and consumption. (ICRISAT) Nutritional insecurity is a major threat to the world's population that is highly dependent on cereals-based diet, deficient in micronutrients. (The Story of Millets)

CHALLENGES IN PRODUCTION OF MILLETS

- Low productivity of millets
- Decline in the area under millet cultivation.
- Processing of millets is a time-consuming and laborious task, mainly undertaken by women.
- Millets selling prices are very low in the APMC (Agricultural Produce Market Committee) mandis
- Unavailability of good-quality millet seeds
- Lack of appropriate processing technologies that yield stable shelf products

ISBN: 9789358913323

- Different processing facilities are needed for different millets
- Absence of proper grades and standards
- Social stigma on millets that they are Poor Man's Food
- Millet-based products are not covered under standard foods
- Absence of market intelligence on millets to analyze the export competitiveness of millets, and price volatility of domestic and international markets

DISCUSSION

Millets do not require pesticides, according to traditional growing techniques and the land used for growing millets is totally pest free. The millets do not need any fumigants. Millets have relatively a lower position in India, among feed crops in agriculture, but they are very important from food security point at regional and farm level. Millets are capable of growing in drought conditions and can withstand higher heat regimes. Millets can grow even in non-irrigated conditions and in very low rainfall regimes in between 200 mm and 500 mm. Millets can face the low water conditions and can grow. Considering the nutritional parameters, millets are way ahead of wheat and rice. In terms of mineral content, millets have more fibre when compared to rice and wheat. Each one of the millets has more fibre than rice and wheat. Some millets have more than fifty times of fibre than of rice. Finger millet is having thirty times more Calcium than rice while all other millets have at least double amount of Calcium compared to rice. In their Iron content, foxtail and little millet are also high in nutritional content compared to rice. Millets offer abundant micronutrients like vitamins, beta-carotene etc which are being consumed like pharmaceutical pills in present day (Ambati K and Sucharitha K.V., 2019).

CONCLUSION

Revitalizing millets into mainstream dryland agriculture and diversifying the food basket is important for sustaining the food, nutritional security of consumers and livelihood security of the rural households. For achieving this, the major challenges are to deliver millet-based technologies which are sustainable and market oriented. This can be achieved through reconsideration of millets research in terms of present and future demand, resolving specific production constraints thereby improving productivity, improved agronomic practices, development of value addition and processing technologies, marketing strategies and policy measures that would generate more income and employment generation to the farmers without sacrificing overall goal of attaining sustainable food and nutritional security. Scientific and technological interventions involving convergence of efforts of agricultural and food scientists, policy makers and media is needed to revalorize millets for attaining food and nutritional security. (The Story of Millets)

ISBN: 9789358913323

REFERENCES:

1. Amadou I., Gounga M.E., and Le G.W. Millets: Nutritional composition, some health benefits and processing – A Review. Emir. J. Food. Agric. 2013. 25 (7): 501-508.
2. Ambati K and Sucharitha K.V. Millets-Review on nutritional profiles and health benefits. International Journal of Recent Scientific Research. 2019. 10 (7): 33943-33948.
3. Bhat B.V., Arunachalam A, Kumar D., Tonapi V.A. and Mohapatra T. Millets in the Indian Himalaya. Indian Council of Agricultural Research (ICAR) - Indian Institute of Millets Research (IIMR), Ministry of Agriculture and Farmers Welfare, Government of India, Krishi Bhawan, New Delhi. 2019.
4. ICRISAT - https://www.icrisat.org/a-short-history-of-millets-and-how-we-are-recognising-their-importance-in-the-modern-context/
5. IIMR (2015) Vision 2050, ICAR- Indian Institute of Millets Research, Rajendranagar, Hyderabad-30. https://www.millets.res.in/vision/vision2050.pdf Accessed 2 Feb 2021
6. Kumar A, Tomer V, Kaur A, Kumar V, Gupta K (2018) Millets: a solution to agrarian and nutritional challenges. Agric Food Secur 7:31. https://doi.org/10.1186/s40066-018-0183-3
7. Kumar P, Joshi PK, Birthal PS (2009) Demand projections for food grains in India. Agric Econ Res Rev 22:237–243. https://doi.org/10.22004/ag.econ.57405
8. Sabuz A.A., Rana M.R., Ahmed T., Molla M.M., Islam N., Khan H.H., Chowdhury G.F., Zhao Q and Shen Q. Health-Promoting Potential of Millet: A Review. Separations. 2023. 10:80.
9. Singh J.P., Rao B.D., Patil J.V. and Ansari A. **Overview of Millets Cultivation in India.**
10. Singh P. The origin and dispersal of millet cultivation in India. Interregional Contacts in the Later Prehistory of North-eastern Africa, Poznan. 1996.
11. Tasks for India's millet revolution. https://www.iastoppers.com/articles/tasks-for-india-s-millet-revolution
12. The Story of Millets. Karnataka State Department of Agriculture, Bengaluru, India. ICAR-Indian Institute of Millets Research, Hyderabad, India.
13. Upadhyay V. Creating Awareness about Millets (Types, Importance, Climate Resilient and Economic Security). RARS, AAU, Gossaigaon. https://www.slideshare.net/vinodupadhyay14661/creating-awareness-about-milletspptx
14. Weber S.A. and Fuller D.Q. Millets and their role in Early Agriculture. 2008.

ISBN: 9789358913323

8. NUTRITIONAL VALUE OF MILLETS AND THEIR ECONOMIC IMPORTANCE

N. Sucheta, Anitha U
BSc 1st year , BZ, Department of Botany, KLE's S.Nijalingappa college

ABSTRACT

Millets have a significant role in the traditional diets of many regions throughout the country. Millets have various advantageous properties like drought resistant, good yielding in areas where water is limited and they possess good nutritive values. Millet are rich with phytochemicals, however, the types and amount present vary greatly between and within the deifferent species. The processing techniques used for the grains, like dehulling and decortication, malting, fermentation and thermal processing, etc, they have affect on the quality of the phenolics present, mostly helps in reducing them. Therefore the phytochemicals levels in the millet foods and beverages have lower than in the cereal grains. There are evidences showing milletfood have beverages have funtional and health-promoting effects, specifically anti-diabetic, anti-obesity, carsiovascualar disaeases.

INTRODUCTION

Millets are highly varied group of the small seeded grasses widely grown around the world as cereal crops or grains as fodder and human food. Most species generally refer to as millets belongs to the high tribe paniceae, but some millets also belonging to the various other taxa. Millets are important crops in the tropics of Asia and Africa (especially in South India, Mali, Nigeria, Niger) with 97% of millect production is in developing countries. Millets are indigenous to many parts of the world. Millets may have been consumed by the humans for about 7000 years and potentially add a important role in the rise of multi crop agriculture and settled farming societies.

There are many types of millets like pearl millet (bajra), foxtail millet (kakum/ kanguli), finger millet (ragi), Proso millet (channa/ barli) etc. Few are mentioned below.

ISBN: 9789358913323

NUTRITIONAL VALUE AND THE ECONOMIC IMPORTANCE OF THE MILLETS:

1. ***PEARL MILLET (Bajra)***

Pearl or bajra is rich composition of the minerals and protiens, pearl millet has health benefits also. Pearl millet has the highest protien content. It contains many essential minerals like magnesium, phosporous, zinc, etc. It contains essential ammonium acids and vitamins also which

contribute to its therapetic properties.

Nutritional value*:* per 100gm of pearl millet can consist of -

Protein	11.6gm
Carbohydrate	*67.5 gm*
Iron	8mg
Carotene	132mg
Fat	5g
Calories	363 kcal

Economic importance:

Pearl millet is the second important millet of India, second to sorghum in area and production. In south India its called “Sajje”. Its one of the coarse crops and it considered to be poor man’s food. Bajra grains are eaten cooked like rice or chapathi are prepared out of flour like maize or sorghum flour . Its also used as the feed for poultry and green fodder or dry kadbi for cattle.

ISBN: 9789358913323

Health benefits:

Nutritious baby foods- pearl millet are easily digested and well tolerated by the little ones which makes them a mandatory ingredient for a baby food preparations during the weaning period and even later on. Lowers blood pressure- bajra also known as pearl millet, rich in potassium which is needed for those with high bp. Consuming foods rich in potassium will help flush out sodium from our blood which in turn will reduce blood pressure. To treat acidity and stomach ulcer- pearl millet is one of the few foods which reduce the acidity of the stomach, thereby limiting ulcer formation and discomfortable due to frequent blots of the *acidity.*

FOXTAIL MILLET (Kunkum/ kanguli)

Its also called as the italian millet and german millet. Its growing in both the tropics and temperate region under low rain fall.Foxtail millet is like a powerhouse of millet compared to other millets. Its rich in vitamin B12, this tiny seeds can offer you a daily dose of ample protien, good fat, carbohydrates and amazing dietry fibre content.

Beside copious amount of lysine, thymine, iron and naicin, it also offers copious amount of calcium. Foxtail millet helps in preventing diabetes to reduce the glucose levels in blood and maintains heart due to magnesium content.

Nutritional value of foxtail: per 100gms of foxtail millet

Protein	12.3g
Carbohydrate	60.2g
Fat	4.2g
Minerals	4g
Fibre	6.7g
Calcium	31mg
Phospoborous	290mg
Iron	2.8mg
Energy	351kcal
Thiamine	0.59mg

Economic importance: ***F***oxtail millet is grow in India since acient times and was consumed as staple food until three to four decades ago. Certainly growing in Andra Pradesh, Karnataka, Tamil Nadu etc. Foxtail millet is a dual purpose plant grown for its grain which is used for human food and animal feeding and as a fodder. It is most commonly used for bird feeding.

ISBN: 9789358913323

Health benefits: Foxtail millet helps in preventing diabetes to reduce the glucose levels in blood and maintains heart due to magnesium content, good for cardiac disease, blood sugar level maintenance, improves immunity etc.

SORGHUM MILLET (Jowar)

This millet has certain properties which makes it suitable to consume by population suffering from chronic diseases. Each sorghum nutrient has specific nutritional significance, which prevent and control the lifestyle, diseases and diseases. East Africa people has used as brew, a drink from this millet that is known as the ajona. Sorghum contains iron, calcium, fibre, protien and wax policosanols which helps to reduce zinc, cholestrol level and other health benefits. Sorghum has glutenin free grain to prefer for celiac person or who cannot tolerate wheat-based products.

Nutritional value: 100g of jowar consists of:

E**conomic importance:**

Calories	329 kcal
Protein	11g
Fat	3g
Carbohydrates	72g
Fibre	7g

Sorghum grain can be like rice, mill it into flour or pop it into popcorn also converted into syrup its used to feed animals and also natural Syrup is used as the natural sweetner.

Health benefits:

Sorghum has glutenin free grain to prefer for celiac person or who cannot tolerate wheat based products. To lower the oxidative stress and inflammation, sorghum is high in antioxidants like flavonoids, phenidic acid, and tannins. Eating a diet rich sorghum can lower the oxidation stress and inflammation.

ISBN: 9789358913323

2. **FINGER MILLET :**

Finger millet also known as the ragi, is an important millet, grow extensively in various region of India and Africa. its scientific name is *Eleusine coracana*. its rank 6th in production after wheat, rice, maize, sorghum and bajra in India. In India the mostly grown and consumed in Karnataka and to a limited extend Andra Pradesh, Tamil Nadu, Odisha etc.

Nutritive value of ragi*:* 100g of ragi can consist of

Protein	6gm
Fat	1.7gm
Crude fibre	3.6gm
Carbohydrates	72gm
Energy	328 kcal

Economic importance;

Finger millet is significantly used for grain and forage never cultivated excessively as fodder. It has methanoic protein which is not find in other cereals. This grain are feed to lactating mothers, pregnant women and as a weaning food for children. Its used in many preprations like chapathi, cakes, sweets, puddling etc.

Heath benefits:

Ragi has high amount of fibres in it, that keeps your stomach full and stopping from unwanted carvings. This helps in weight loss.it reduces the level of blood sugar in your blood and turns into insulin. Ragi is the best suited when you consume it in morning.

ISBN: 9789358913323

3. PROSO MILLET

Proso millet is a unique Indian millet that is commonly known as the white millet. It's a wide grass species that was domesticated aa a crop somewhere around 7000 years ago in China. This millet is now cultivated in India, Middle east, Turkey, Russia and the United State

Nutritional value: 100gm of proso millet can consist of:

Energy	334 kcal
Carbohydrates	68.5gm
Deitry fibre	14.6gm
Protein	12.5gm
Fat	1.1gm

Economic importance:

Proso millet cultivated booth as a food and fodder thus providing food or livelihood security to millions of household and contributing to the economic efficiency of farmer. Millets contribute to multigating climate changes as it helps reduce the atmospheric carbon pressure CO2.

Health benefits:

Proso millet has an anti ageing capacity: It's a good source of antioxident which helps in removing free radicles from the body. Free radicals are produced in almost every process of the body. To lowering cholestrol: proso millet has shown science of reducing the cholestrol levels. The presence of HDL's increase the metabolism of cholestrol and helps bring it under control.

CONCLUSION:

Now, it is an established fact that the whole world is facing many heath challenges because of fibre-less foods. Its also clear to 1000s of patients that all the lifestyle diseases can be made to disappear just by eating millets for breakfast, lunch and dinner and removing refined

foods like rice, wheat, refined flours, processed meats, refined oils, packed and ready to consume kind of foods and milk.

Millets have multiple health benefits to include this ancient prized grain like seed in our regular diet. Most of the civilized people have not even heard about millets and much less understand the benefits of millets nutrition. And yet, millet is one of the best kept secret of our ancient ancestors.

ISBN: 9789358913323

Phytosterols and policosanols are cardioprotective compounds present in the waxy layer of millets. If these millets are ground into flour without de-hulling, then one can gain multiple benefits. Millets are anti-oxidants, which are substance that may protect our cells against the effects of free-radicals.

REFERENCES:

1. Ali, R. Staub, J. Levelle, G.A. Boyle and co-workers _ deitary fibre in health and disease.
2. Arora.S, Jood .S and co-workers - nutritional profile based on the pearl millets and its benefits.
3. Dayakar Rao- Multi millets of its India and its benefits.
4.Bhaskaracharya VY - Nutritional value of millets.
5.Chandrashekara. A and Shahidhi.F - Journal of functional foods.
6.Ganapathy.KN - small grains and a big grains among millets.
7. Reddy OSK- smart millet and human health.
8. Shwetha Malik- pearl millet nutritional value and health benefits.
9.Upadhaya HD, Gowda CLL- morphology diversity in finger millet
10.Veena B- nutritional, functional, utilization study

ISBN: 9789358913323

NATIONAL SEMINAR REPORT

KLE Society's

S. NIJALINGAPPA COLLEGE, BANGALORE-10
NATIONAL LEVEL SEMINAR (2022-23)
DEPARTMENT OF BOTANY
PHYTON CLUB

Date : 27-02-2023
Topic : Contribution of Millets to Human Health and Wealth (CMHW)
Speaker : Dr. Sukanya T.S
Principal Scientist, PC Unit, AICRP on Small Millets
UAS, GKVK, Bengaluru
Beneficiaries: UG and PG students (136 students)

On the eve of celebration of International year of Millets as declared by United General assembly which was proposed by our Prime minister Sri Narendra Modiji, Department of Botany under Phyton Club organized one day National level Seminar on "**Contribution of Millets to Human Health and Wealth**". The seminar was conducted on a blended mode using google meet platform and You tube live streaming. The programme started with Invocation Song by Ms Shalini S, II Bsc student followed by welcome speech by Dr. Banani Misra, Organizing secretary, CMHW, Assistant professor, department of Botany. Introduction to chief guest Dr. Sukanya T.S was delivered by Smt. Roopashree MG, HOD Botany, Convenor, CMHW. Then the program proceeds with the Key note address by the chief Guest Dr. Sukanya T. S. on topic "**Nutricereals: Role in Indian Agriculture, Food and nutritional security".** She explained about the significance of the Future Grain -Millets and the importance of millets to empower poor grade farmers, sustainable development and climate change. The session was really wonderful and informative. The session was presided over by our beloved principal Dr. Arun Kumar B Sonappanavar. While giving presidential remarks he emphasized and reiteratered on the significance and nutritional value of millets. Presidential remark was followed by by paper presentation after tea break. There were many oral presenters from different states like Orissa, Tumkur, Hubballi, and different colleges of Bengaluru participated and presented paper on nutritional and health benefits of millets. Paper presentation was followed by valedictory session post lunch. Certificate distribution was completed by our Principal Dr. Arun Kumar B Sonappanavar sir. The program concluded with the Vote of thanks by Ms. Likitha M, II Bsc student.

Really this seminar was having a wonderful take away in which our students learned about the importance of Future grain which is having low Carbon and Water Foot Print.

ISBN: 9789358913323

ISBN: 9789358913323

ISBN: 9789358913323

ISBN: 9789358913323

ISBN: 9789358913323

ISBN: 9789358913323

K.L.E. Society's

S. NIJALINGAPPA COLLEGE

Rajajinagar, Bengaluru-560 010

(Re-Accredited with 'A+' Grade by NAAC)

Phone: 080-23526055, 080-23325020, Fax 080-23320902

Website: www.klesnc.orgE.mail: info@klesnc.orgkleaccts@yahoo.com