Journal of Scientific Research and Reports

Volume 30, Issue 6, Page 706-714, 2024; Article no.JSRR.112684
ISSN: 2320-0227

Millets as an Ancient Grains for Modern Food Security and Sustainable Agriculture

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Authors' contributions

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

Article Information

DOI: https://doi.org/10.9734/jsrr/2024/v30i62089

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/112684

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Cite as: *Singh , B. D., Abhishek , G. J., Priya P., Kumar , S., Shinde , S. P., Kumar , S., Bhushan , S., Behera , M., Vajha , M., & Pandey , A. K. (2024). Millets as an Ancient Grains for Modern Food Security and Sustainable Agriculture. Journal of Scientific Research and Reports, 30(6), 706–714. https://doi.org/10.9734/jsrr/2024/v30i62089*

Review Article

Received: 01/01/2024
Accepted: 05/03/2024
Published: 30/05/2024

ABSTRACT

Millets, a group of small-seeded grasses, represent a diverse set of cereal crops that have been cultivated for millennia. They offer numerous nutritional, environmental, and economic benefits, yet they remain underutilized in many parts of the world. This paper explores the potential of millets as a key component of efforts to ensure food security in the face of climate change, population growth, and environmental degradation. Millets are highly resilient to drought, pests, and diseases, making them well-suited to marginal growing conditions. Additionally, they boast nutritional profiles rich in protein, fiber, vitamins, and minerals, addressing malnutrition and diet-related health issues. Furthermore, millet cultivation promotes biodiversity, reduces water consumption, and enhances soil fertility, contributing to sustainable agricultural practices. Despite their advantages, millets face challenges such as limited awareness, lack of infrastructure, and policy neglect. Thus, concerted efforts are needed to promote research, improve market access, and raise consumer awareness to unlock the full potential of millets in ensuring food security and promoting sustainable agriculture globally.

Keywords: Millets; food security; grains; nutrition.

1. INTRODUCTION

“High-energy meals such as millets or nutri-cereals were domesticated and grown as early as 10,000 years ago” [1]. “Millets are considered a major grain in the world, however they are the least used. Because millet grain is high in nutrients and phenolic compounds that are good for health” [2]. “Typically, marginal and degraded areas with little rainfall and low soil nutrient content are used for millets growth. A handful of millets is said to contain thousands of grains, as the name "millet" comes from the French word "mile," which means thousand” [3]. “The purpose of millets, also known as mini millets, is to produce tiny kernels, which are the offspring of small Poaceae family grassland plants. Although they go by a different name, minor millets are significant crops because of their nutritional worth, therapeutic uses, ability to feed animals, and ability to survive a food crisis” [4]. Millets are a nutritious, locally grown grain that is high in bioactive compounds, low in GI, high in fiber, and a wonderful source of gluten-free protein. They also offer protection against diabetes and cardiovascular disease [5-7].

“The principal nutri-cereals farmed in India consist of pearl millet, also known as bajra (*Pennisetum typhoides*), finger millet, also known as mandua/ragi (*Eleusine coracana*), foxtail millet, also known as kangni (*Setaria italica*), little millet, also known as kutki (*Panicum miliare*), kodo millet, known as kodo millet, sawan or barnyard millet (*Echinochloa frumentacea*), proso millet, also known as cheena (*Panicum miliaceum*), and brown top millet, also known as korale (*Brachiaria ramosum*)” [5]. In some Indian states, there have been multifaceted institutional initiatives focused on millets with the goal of boosting both rural and urban output. The Ministry of Agriculture and Farmers Welfare, GOI, refers to the very diversified group of grasses known as millets as Nutri-cereals. Tiny millets are all members of the Poaceae (true grass) family. Due to their tiny size, millet seeds thrive in arid environments (Tadele, 2016). It's a crop that can withstand drought and be kept pest-free for an extended period of time. It is best suited for dry culture; however, the labor-intensive cultivation process lowers its cultivation value. The world's largest producer is India. Pearl millet, the most widely grown type of millet, is a significant crop in regions of Africa and India (Tadele, 2016). While the overall amount of sorghum produced in India has grown recently, the amount produced on a small scale has decreased dramatically over the years, from 5.29 million hectares to 0.97 million hectares. In India, Karnataka is the state that produces the most foxtail millet. Although more than 58% of the world's output is millet, not many people are aware of its nutritional and health benefits [6].

It is crucial to investigate strategies for raising public knowledge of the nutritional advantages of millet. Exploring these underutilized/neglected

species can contribute to sustainability, ecological diversification, rural people's economic empowerment, and nutritional and health security all of which the modern world desperately needs [7]. In recent years, there has been a growing global interest in rediscovering traditional and nutritious food sources [8-10]. Among these, millets have emerged as a promising nutritional and agrarian solution to address the challenges of food production, especially in the face of climate change. This review explores the nutritional benefits, agrarian advantages, and the potential role of minor millets in ensuring food security.

2. HEALTH BENEFITS AND NUTRITIONAL VALUE OF MILLETS

Millets offer a range of health benefits and possess significant nutritional value, making them valuable additions to diets worldwide. Here are some of the health benefits and nutritional components of millets:

1. Rich in Nutrients: Millets are packed with essential nutrients including carbohydrates, proteins, dietary fiber, vitamins, and minerals. They are particularly high in magnesium, phosphorus, manganese, and iron, which are vital for various bodily functions including energy metabolism, bone health, and oxygen transport [11,12].

2. High Protein Content: Millets are considered a good source of plant-based protein, making them an important component of vegetarian and vegan diets. They contain essential amino acids, which are the building blocks of proteins necessary for muscle repair, growth, and overall health [13,14].

3. Low Glycemic Index: Millets have a low glycemic index (GI), which means they release glucose into the bloodstream slowly, leading to gradual and sustained energy release. This makes them suitable for individuals with diabetes or those looking to manage blood sugar levels.

4. Rich in Dietary Fiber: Millets are abundant in dietary fiber, which promotes digestive health, prevents constipation, and helps regulate blood cholesterol levels. The fiber content in millets also contributes to a feeling of fullness and aids in weight management.

5. Gluten-Free: Millets are naturally gluten-free, making them suitable for individuals with gluten intolerance or celiac disease. They serve as excellent alternatives to gluten-containing grains like wheat, barley, and rye.

6. Antioxidant Properties: Some varieties of millets, such as finger millet (ragi), contain antioxidants like polyphenols and flavonoids, which help protect cells from damage caused by harmful free radicals. Antioxidants also play a role in reducing the risk of chronic diseases such as cancer, heart disease, and inflammation.

7. Heart Health: The high fiber content and presence of heart-healthy fats in millets contribute to cardiovascular health by lowering cholesterol levels, reducing blood pressure, and decreasing the risk of heart disease and stroke.

8. Weight Management: Millets are considered a weight-friendly food due to their low calorie and fat content, high fiber content, and ability to keep you feeling full for longer periods. Incorporating millets into your diet can help support weight loss and weight management efforts.

Overall, millets offer a nutritious and versatile option for promoting overall health and well-being. Incorporating a variety of millets into your diet can help diversify nutrient intake and contribute to a balanced and wholesome eating pattern.

3. RICH IN NUTRIENTS

Numerous vital components, including vitamins, minerals, and dietary fiber, may be found in abundance in millets, especially those grouped together in minor millets. These grains greatly contribute to a healthy diet by offering a nutritional profile that is well-balanced. Millets are nutritionally comparable to ordinary cereals, if not more so in terms of calories, protein, and macronutrient concentrations. Unlike rice and wheat, millets are a strong source of micronutrients such vitamins A, B, D, E, niacin, pyridoxine, antioxidants, iron, and zinc in addition to being high in calories and key nutrients like protein. Compared to rice and wheat, millets contain higher protein contents (10–12.3 g/100 g), fat contents (1%–5%), iron contents (0.5–19.0 mg), and calcium contents (10–410 mg) [15]. They are a valuable complement to the diets of both humans and animals because of their high calorie content, calcium, iron, zinc, lipids, and quality proteins. They are also great sources of nutritional fiber and vitamins [15-18].

Gluten-Free Alternative: Millets is inherently gluten-free, making it an excellent alternative for

Table 1. Comparing the nutritional makeup of millets with typical grains

Composition	Rice	Wheat	Maize	Millets
Protein (%)	7.5	14.4	12.1	7.3–14.5
Carbohydrates (%)	77.2	64	62.3	56.1–72
Fat (%)	2.4	2.3	4.6	1.3–5.1
Dietary fibers (%)	3.7	12.1	12.8	7.0–37.8
Total phenols (mg/100 g)	2.51	20.5	2.91	51.4–368
Calcium (%)	0.02	0.04	0.03	0.01–0.33
Iron (%)	19	40.1	30	18–21.9
Zinc (%)	10	30.9	20	15–29.5
Sodium (%)	0.00	0.04	0.14	0.11
Thiamine (mg/100 g)	0.07	0.57	0.38	0.32–0.63
Riboflavin (mg/100 g)	0.03	0.12	0.14	0.05–0.22
Nicotinic acid (mg/100 g)	1.6	7.4	2.8	0.3–3.7

(Source: Devi et al.[15]

Table 2. Comparative nutritional values of selected millets

Millets/Nutrient	Protein (g)	Fibre (g)	Minerals (g)	Iron (mg)	Calcium (mg)
Pearl/Kambu Millet	10.6	1.3	2.3	16.9	38
Finger/Ragi Millet	7.3	3.6	2.7	3.9	344
Foxtail/Tenai Millet	12.3	8	3.3	2.8	31
Proso/Panivaragu Millet	12.5	2.2	1.9	0.8	14
Kodo/Varagu Millet	8.3	9	2.6	0.5	27
Little/Samai Millet	7.7	7.6	1.5	9.3	17
Barnyard/Kuthiraivali Millet	11.2	10.1	4.4	15.2	11

individuals with gluten sensitivity or celiac disease. The rising prevalence of gluten-related disorders has increased the demand for gluten-free grains, positioning millets as a viable option.

3.1 Low Glycemic Index

The low glycemic index of millets makes them suitable for individuals with diabetes. Millets can help regulate blood sugar levels, providing a steady release of energy and promoting better overall health.

4. MINERALS AND VITAMINS CONTENT IN MILLETS

The minerals and vitamins are known as micronutrients as they are needed in petite amount [19-20]. Minerals instigate in the building of bones, blood clotting, transmitting signals, keeping normal heart beat, cell energy production, transportation of oxygen, metabolize and synthesize fats and proteins, act as co-enzymes, provide immunity to the body and help nervous system work properly.

- **Calcium content**: Calcium content of finger millet is about eight times higher than wheat and being the richest source of calcium (348 mg/100 g) and it has the capability to prevent osteoporosis.
- **Iron content:** The iron content of barnyard millet is 17.47 mg/100 g which is only 10 mg lower than the needed daily value and their consumption can meet the iron demand of pregnant women suffering from anaemia.
- **Zinc content**: “Foxtail millet contains loftiest amount of zinc (4.1 mg/100 g) among all millets and is also a good source of iron (2.7 mg/100 g) contributing an important role in boosting the immunity” [16]
- **Vitamins:** Millets are also good source of β-carotene and B-vitamins especially riboflavin, niacin and folic acid.

5. HEALTH BENEFITS OF MILLETS

Millets have been traditionally used as a staple food in many parts of the world. They are rich in fibre, protein, vitamins, and minerals, and have been found to have several health benefits, including:

1. **Cardiovascular disease** (CVD) is a group of disorders that affect the heart and blood vessels, and includes conditions such as

coronary artery disease, heart failure, and stroke. CVD is a major cause of death and disability worldwide, and several risk factors have been identified, including high blood pressure, high cholesterol, diabetes, and obesity. Millets have been found to have several properties that may be beneficial for reducing the risk of CVD, including:

- High fiber content: Millets are rich in dietary fiber, which has been found to reduce cholesterol levels in the blood and improve overall cardiovascular health.
- Low glycemic index: Millets have a low glycemic index, which means they do not cause a rapid increase in blood sugar levels, and may be beneficial for people with diabetes.
- Antioxidant properties: Millets are rich in antioxidants, which help to reduce inflammation and oxidative stress in the body, both of which are risk factors for CVD.
- Low in fat: Millets are low in fat, particularly saturated fat, which is a major risk factor for CVD.
- Gluten-free: Millets are gluten-free, which makes them a suitable option for people with celiac disease or gluten intolerance.

Overall, incorporating millets into a healthy and balanced diet may be beneficial for reducing the risk of cardiovascular disease. However, it is important to note that a balanced diet and regular physical activity are the most important factors in reducing the risk of CVD, and millets should be consumed as part of a varied diet [21-22].

2. **Celiac disease:** Millets are naturally gluten-free, which makes them a suitable food option for people with celiac disease.

- Celiac disease is an autoimmune disorder that affects the small intestine's ability to absorb nutrients from food properly. When people with celiac disease consume gluten-containing foods, their immune system reacts and damages the small intestine's lining, leading to a range of symptoms such as abdominal pain, diarrhoea, fatigue, and weight loss.
- Millets such as sorghum, foxtail millet, pearl millet, and finger millet are excellent alternatives to gluten-containing grains such as wheat, barley, and rye. These grains are high in fiber, protein, vitamins, and minerals and can be used to make a variety of dishes such as porridge, bread, pancakes, and even desserts.
- However, it's essential to ensure that the millets you purchase are certified gluten-free as some millets may be cross-contaminated with gluten during processing or transportation. It's also essential to read food labels carefully to avoid products that contain gluten-containing ingredients or were processed in facilities that handle gluten-containing products.
- In summary, millets are a great option for people with celiac disease looking for gluten-free grains to include in their diet. However, it's important to ensure that the millets you consume are certified gluten-free to avoid cross-contamination with gluten

3. **Diabetes:** Millets are a good choice for people with diabetes as they are low in glycemic index, which means they are digested slowly and do not cause a rapid increase in blood sugar levels. Millets also contain complex carbohydrates, dietary fiber, and minerals like magnesium and potassium, which are important for people with diabetes.

- Foxtail Millet: It is a rich source of dietary fiber and has a low glycemic index. It also contains antioxidants that can help lower blood sugar levels.
- Finger Millet: It is rich in fiber and has a low glycemic index. It is also rich in phytochemicals like polyphenols and flavonoids, which have antioxidant properties.
- Barnyard Millet: It is rich in fiber, protein, and low in carbohydrates. It also has a low glycemic index and can help in managing blood sugar levels.
- Kodo Millet: It is rich in dietary fiber and has a low glycemic index. It is also a good source of protein and minerals like iron and calcium.
- Little Millet: It is rich in dietary fiber and has a low glycemic index. It is also a good source of protein and minerals like magnesium and potassium.

5.1 Climate Resilience

Millets are known for their adaptability to diverse climatic conditions. Minor millets varieties are particularly resilient to drought, making them a valuable crop in regions facing water scarcity. This resilience contributes to the sustainability of agricultural practices.

In addition, the current state of climate change is having a significant influence on natural resources and agricultural productivity, which in turn affects food production and livelihoods. For instance, FAO figures show that as of 2019, over 820 million people worldwide were still hungry, underscoring the tremendous challenge of reaching the Zero Hunger target by 2030. Two billion people worldwide experience moderate to severe food insecurity, which is another alarming fact (Jeena et al., 2020). Reorienting efforts toward sorghum and millets is now necessary in order to create demand for processed foods through value addition, technological diversification, nutritional assessment, and awareness-raising supported by backward integration. Given the current state of climate change, drought, and water scarcity, millets have emerged as a potentially viable and highly nutritious option for ensuring food security in a sustainable manner [23-25]

5.2 Soil Health

Millets are well-suited for sustainable farming practices. They require fewer inputs like water and synthetic fertilizers compared to conventional cereal crops. The cultivation of minor millets helps improve soil health, reducing the environmental impact of agriculture.

5.3 Crop Diversity and Biodiversity

Integrating minor millets into agricultural systems promotes crop diversity, which is crucial for overall ecosystem health. Additionally, millet cultivation supports biodiversity by providing a habitat for various beneficial insects and microorganisms. Climate resilience and adaptability to diverse conditions. Reduced water and fertilizer requirements compared to conventional crops [26-29].

5.4 Affordability and Accessibility

Millets are often more affordable than other grains, making them accessible to a broader population. Minor millets can play a crucial role in addressing food security challenges by providing a cost-effective and nutritious food source.

5.6 Community Empowerment

The cultivation and consumption of millets can empower local communities, especially in rural areas. Supporting millet farming can contribute to the growth of economic, thus reducing dependency on the external food sources.

The present Scenario National Millets Mission (NMM) was launched in the year 2007 to promote production and consumption of the millets. Regarding this, Karnataka has taken up many steps to popularize production and consumption of millets in India. It set up cooperatives to streamline supply chain. Many millet based start-ups were also established to popularise its uses in the country. In Maharashtra, people have been consuming millets for many decades. Many processing units have established to provide the white millets (Ragi) within the communities. It is still one of the main staple crops in the state of Maharastra. Orissa Government had also initiated a special millets programme in tribal areas and introduced Odissa Millet Mission in 2017 for promotion of the millets [31-32]. Chhattisgarh Government have been established State Millet Mission in 2021, aimed to boost the production, provide employment to the farmers, women groups, as well as youths. Rajasthan has been growing Bajra traditionally and is the largest producer of Bajra in India. But in the recent years the trend of consumption is decreasing. The tribal area in southern Rajasthan is known to have staple nutritious millet called Kutki but in the modern times these millets uses have been only limited to the old aged persons who had grown the crops in their kitchen gardens. The Prime Minister had highlighted the brainstorming sessions shall be held on topics such as millets farming, millets economy, health benefits and farmers income among others with active participation of Gram Panchayat, Krishi Kendras, colleges, schools, and agricultural universities along with Indian embassies and several foreign countries. He elaborated that millets are not only limited to just food or the farming. Giving examples of minor millets such as Ragi, Sama, Kangni, Cheena, Kodon, Kutki, and Kuttu that are the prevalent in different regions of the India. The Prime Minister mentioned that millets has been a part of lifestyle in India for many years. India government has introduced millets in Public Distribution System to make it easily accessible

and affordable to the masses and Price Support Scheme (PSS) to provide financial assistance to farmers for the cultivation of millets.

6. CONCLUSION

In conclusion, millets stand out as nutritional powerhouses with numerous health benefits, making them valuable additions to diets worldwide. Their rich nutrient content, including protein, fiber, vitamins, and minerals, contributes to overall health and well-being. Millets are particularly beneficial for individuals seeking gluten-free, low-glycemic index, and heart-healthy food options.

Moreover, millets' resilience to adverse growing conditions makes them crucial for sustainable agriculture and food security, especially in regions prone to drought, pests, and diseases. Their ability to thrive with minimal water and input requirements enhances agricultural resilience in the face of climate change and environmental degradation. Despite their remarkable nutritional and environmental advantages, millets remain underutilized and underappreciated in many parts of the world due to limited awareness, infrastructure, and policy support. Thus, concerted efforts are needed to promote research, improve market access, and raise consumer awareness about the benefits of millets.

Incorporating millets into diets and agricultural systems holds promise for addressing malnutrition, promoting sustainable agriculture, and ensuring food security for present and future generations. By recognizing and harnessing the potential of millets, we can contribute to healthier individuals, communities, and ecosystems while building resilient food systems capable of meeting the challenges of the 21st century [33-35].

Millets, encompassing various millet varieties, present a holistic solution to the challenges faced by modern agriculture and nutrition. With its exceptional nutritional profile, adaptability to diverse climates and positive impact on agrarian ecosystems, minor millets emerges as a sustainable and resilient option for addressing food production challenges. As we strive towards a more sustainable and inclusive global food system, the rediscovery and promotion of minor millets represent a promising step forward. Minor millet is emerging as a holistic development medium in India. It provides a gateway to prosperity for the country's tiny farmers. There are around 2.5 crore small farmers directly involved in the production of millets in India; therefore, increasing the market for millets will undoubtedly strengthen the rural economy. India is endowed with hundreds of nutritious crops whose research and development is still poorly addressed. Millets are storehouse of dozens of nutrition in large quantity and long term consumption of millets may bring several health benefits of the people hence they can help resist malnutrition. Production of millets has numerous securities such as securities of food, nutrition, fodder, fiber, health, livelihood and ecology and at the same time increase the development of vulnerable people.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Taylor JR. Sorghum and millets. In Elsevier eBooks. 2019;1–21.
Available:https://doi.org/10.1016/b978-0-12-811527-5.00001-0
2. Hassan ZM, Sebola NA, Mabelebele M. The nutritional use of millet grain for food and feed: a review. Agriculture & Food Security. 2021;10(1).
Available:https://doi.org/10.1186/s40066-020-00282-6
Available:http://nsdl.niscair.res.in/jspui/bitstream/123456789/527/1/Millets%20(Sorghum,%20Pearl%20Millet,%20Finger%20Millet)%20-%20%20Formatted.pdf
Accessed on: 10 April 2023.
3. Singh S, Yadav RN, Tripathi AK, Kumar M, Kumar M, Yadav S, Kumar D, Kumar S, Yadav R. Current status and promotional Strategies of Millets: A review. International Journal of Enviornment and Climate Change. 2023;13(9):3088–3095.
Available:https://doi.org/10.9734/ijecc/2023/v13i92551
4. Yenagi NB, Handigol JA, Ravi SB, Mal B, Padulosi S. Nutritional and technological advancements in the promotion of ethnic and novel foods using the genetic diversity of minor millets in India. Indian J Plant Genet Res. 2010;23(1):82–86.
5. ICRISAT. Small millets; 2017.
Available:http://www.icrisat.org/ homepage

6. Upadhyaya HD, Gowda CLL, Reddy VG. Morphological diversity in finger milletgermplasm introduced from Southern and Eastern Africa. The Journal of Semi-Arid Tropical Agricultural Research. 2007;3:1-3.
7. Nazneen S, Sultana S. Green Synthesis and Characterization of Cissus quadrangularis. L stem mediated Zinc Oxide Nanoparticles. Plant Science Archives. 2024;1(05).
8. Sultana MA, Hansda N, BM NN, H, Noopur K. Protected Vegetable Crop Production for Long-term Sustainable Food Security. Journal of Scientific Research and Reports. 2024;30(5):660-669.
9. Kushwah N, Billore V, Sharma OP, Singh D, Chauhan APS. Integrated Nutrient management for optimal plant health and crop yield. Plant Science Archives; 2024.
10. McDonough CM, Rooney LW, Saldivar S. The millets. In K. Kulpand & Ponte JG, Jr. (Eds.), Handbook of cereal science and technology. New York, NY: Marcel Dekker Inc. 2000;177–195.
11. Devi OA, Saikia AR, Ghorband AS, Saikanth DRK, Badekhan A, Aresh J, Gireesha D. Shree Anna (Millets): A Nutritional and Agrarian Solution to Food Production. Journal of Scientific Research and Reports. 2024;30(5):316-327.
12. Kumar V, Sharma AK, Dwivedi SV. Shree Anna: The Nutritional Powerhouse Paving the Path for Health Security in India. International Journal of Plant & Soil Science. 2024;36(6):230-240.
13. Gangaiah. Agronomy- Kharif Crops Finger Millet; 2008.
14. International Rice Research Institute (IRRI). Steps to successful rice production. Rice production manual, Los Banos (Phillipines); 2015.
Available:www.knowledgebank.irri.org.
Accessed on:10 April 2023.
15. Sangappa DR, Ravi SC, Charishma E. Assessment of millet Stakeholders perception towards millets training program during international year of millets.
16. Azra BH, Fatima T. Zinc nanoparticles mediated by Costus pictus leaf extract to study GC-MS and FTIR analysis. Plant Science Archives. 2024;11-15.
17. Kannan SM, Thooyavathy RA, Kariyapa RT, Subramanian K, Vijayalakshmi K. Seed production techniques for cereals and millets. In: Vijayalakshmi K, editor. Seed node of the revitalizing rainfed agriculture network Centre for Indian knowledge systems (CIICS). 2013:1-39.
Available:http://www.ciks.org/downloads/seeds/5.%20Seed%20Production%20Techniques%20for%20Cereals%20and%20Millets.pdf
Accessed on:10 April 2023.
18. Laishram B, Dutta R, Devi OR, Ngairangbam H. Importance of millets for food and nutritional security in the context of climate resilient agriculture. Advances In Agronomy. 2023;1.
19. Okunlola AI, Opeyemi MA, Adepoju AO, Adekunle VAJ. Estimation of carbon stock of trees in urban parking lots of the Federal University OF Technology, Akure, Nigeria (Futa). Plant Science Archives; 2016.
20. Singh P, Raghuvanshi SR. Finger millet for food and nutritional security. Afr. J. Food Sci. 2012;6:77-84.
21. Leder I. Sorghum and Millets. Cultivated plants, primarily as food sources. In: Gyargy F, editor. Encyclopedia of life support systems, UNESCO, Eolss Publishers, Oxford; 2004.
22. Mbithi-Mwikya S, Ooghe W, Van Camp J, Nagundi D, Huyghebaert A. Amino acid profile after sprouting, Autoclaving and lactic acid fermentation of finger millet (Elusine coracana) and kidney beans (*Phaseolus vulgaris* L.). J. Agric. Food Chem. 2000;48:3081-5.
23. Sultana N, Saini PK, Kiran SR, Kanaka S. Exploring the antioxidant potential of medicinal plant species: A comprehensive review. Journal of Plant Biota; 2023.
24. Kushal Sachan, Anshul Saxena, Suneel Kumar, Abhishekh Mishra, Archana Verma, D.D Tiwari, Anil Kumar [2024]. Urban Soil Health Check and Strategies for Monitoring and Improvement. Journal of Diversity Studies.
Available:https://doi.org/10.51470/JOD.2024.03.01.20
25. Touseef M. Exploring the complex underground social networks between plants and mycorrhizal fungi known as the wood wide web. Plant Science Archives. 2023;08(01):5.
26. Rahat KMR, Amin MA, Ahmed MT. Comparing Tourists' Travel Cost and Consumer Surplus to Estimate the Recreational Values of Kuakata Sea Beach in Bangladesh. J Tourism Hospit. 2024;13:541.
27. Devi PB, Vijayabharathi R, Sathyabama S, Malleshi NG, Priyadarisini VB. Health

benefits of finger millet (*Eleusine coracana* L.) polyphenols and dietary fiber: A review. J Food Sci Technol. 2014;51: 1021–40.

28. Reddy CA, Oraon S, Bharti SD, Yadav A. K, Hazarika S. Advancing Disease Management in Agriculture: A Review of Plant Pathology Techniques. Plant Science Archives; 2024.
29. Md. Tanvir Ahmed, Md. Al Amin. Perilous Resurgence of Dengue Fever in Bangladesh: Gender based perspectives on risk perception and adaptation strategies. Universal Journal of Public Health. 2023;11(5):751 - 760. DOI: 10.13189/ujph.2023.110525.
30. Asma J, Subrahmanyam D, Krishnaveni, D. The global lifeline: A staple crop sustaining twothirds of the world's population. Agriculture Archives; 2023.
31. Hanumanta D Lamani, R VijayKumar, H. Lembisana Devi, Saleha Parveen [2024]. Climate Crisis Chronicles: Understanding Global Warming's Impact and Solutions. Journal of Diversity Studies.
32. Aparanjitha R, Imran GM, Mondal K. Nano fertilizers: Revolutionizing Agriculture for Sustainable Crop Growth. Agriculture Archives. 2023;2.
33. Alemu TT. Effect of storage time and room temperature on physicochemical and geometric properties of banana (Musa Spp.) Fruit. Journal of Plant Biota. 2023;30-40.
34. Sapna, Vijay Kumar, Kushal Sachan, Abhishek Singh. IoT Innovations Revolutionizing Agricultural Practices for Sustainability. Journal of Diversity Studies; 2024. https://doi.org/10.51470/JOD.2024.03.01.29
35. Soetan KO, Olaiya CO, Oyewole OE. The importance of mineral elements for humans, domestic animals and plants—A review. Afr. J. Food Sci. 2010;4(5): 200–22.

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