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A CRITICAL REVIEW AND ANALYSIS OF ROLE OF MILLETS IN ACHIEVING SUSTAINABLE DEVELOPMENT GOALS

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ABSTRACT
The United Nations in 2015 adopted 17 goals as part of the 2030 Agenda for Sustainable Development which set out a 15-year plan to achieve the Goals. For sustainable development to be achieved, it is crucial to harmonize core elements: economic growth, social inclusion and environmental protection. These elements are interconnected and all are crucial for the well-being of individuals and societies. Millets are highly nutritious, climate resilient, farmer friendly, affordable crops whose production and consumption has a huge impact on achieving UN SDGs. The present article aims to critically review and analyse the use of Millets in achieving the goals.

KEYWORDS: Millets, Sustainable development goals, Trina dhanya, Worlds To Do List.

INTRODUCTION
Millet are grasses with small seeds, used as fodder and human food from a very long time. According to the Food and Agriculture Organization of the United Nations (FAO), Asia and Africa are the predominant growers, while India, Niger, and China are the three most high-yield countries.[1] There are different varieties of crop species which include sorghum, pearl millets, Finger millet, proso millet, little millet, foxtail millet, adlay millet, barnyard millet and so on cultivated across the globe.

Ayurveda, the ancient life science gives immense importance to the diet of both healthy and diseased. Millets are described in Ayurveda as Trinadhanya in the category of cereals in detail explaining their pharmacological profile. Analysing the general qualities and effects of millets told in Ayurveda it is very clear that millets are best suitable in disorders of Kapha (ex: Obesity, DM), Pitta (Gut problems) and Rakta(blood disorders). Based on this understanding the gross indications for use of millets are, Sthoulya (obesity), Kushta (skin diseases), Prameha (Diabetes), Atisaara (Diarrhea), Medoroga (Diseases due to excessive lipids), Vrana (wounds and ulcers) and other Santarpanajanya Vyadhi (diseases due to over nourishment of single or multiple tissues) which are usually lifestyle disorders.[2]

Sustainable development has been defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. The Sustainable Development Goals are a universal call to action to end poverty, protect the planet and improve the lives and prospects of everyone, everywhere. The UN Secretary-General called on all sectors of society to mobilize for a decade of action on three levels: **global action** to secure greater leadership, more resources and smarter solutions for the Sustainable Development Goals; **local action** embedding the needed transitions in the policies, budgets, institutions and regulatory frameworks of governments, cities and local authorities; and **people action**, including by youth, civil society, the media, the private sector, unions, academia and other stakeholders, to generate an unstoppable movement pushing for the required transformations.[3]

The 17 sustainable development goals (SDGs) adopted are: No Poverty, Zero Hunger, Good Health and Well-being, Quality Education, Gender Equality**,** Clean Water and Sanitation, Affordable and Clean Energy, Decent Work and Economic Growth, Industry, Innovation and Infrastructure , Reduced Inequality, Sustainable Cities and Communities, Responsible Consumption and Production, Climate Action, Life Below Water, Life on Land, Peace and Justice Strong Institutions and Partnerships to achieve the Goal. The present article explores to what extent millets play a role in achieving them.[3]

An electronic search was done on Ayush Portal, PubMed, Dhara, Research Gate, Scopus, Ayu, Google Scholar, Academia, and Google to review and collect information related to Millets. The information related to Sustainable development goals were collected from the UN websites. The collected information was further reviewed analyzed and drawn conclusions.

GOAL 1: No Poverty

Eradicating extreme poverty for all people everywhere by 2030 is a pivotal goal of the 2030 Agenda for Sustainable Development. The Covid 19 pandemic, rising inflation, war in Ukraine and such factors have contributed to rising poverty globally. There is a strong bidirectional link between poverty and disability. Poverty may cause disability through malnutrition, poor healthcare, and dangerous living conditions. Case studies in developing countries show that higher disability rates are associated with higher rates of illiteracy, poor nutritional status, lower immunization coverage, lower birth weight, higher rates of unemployment and underemployment, and lower occupational mobility.[3] Millets abode vital nutrients and the protein content of millets grains are considered to be equal or superior in comparison to wheat (*Triticum aestivum*), rice (*Oryza sativa*), maize (*Zea mays*) and sorghum (*Sorghum bicolor*) grains.[4] There by millets are super grains which provide nourishment in affordable price. Thus help in improving the nutritional status of public. Millets contribute to economic security because: climate resilient crop, sustainable income source for farmers, low investment needed for production.[4] Production of millet based contemporary food recipes such as Biscuits, Cookies etc on a large scale can help in combating unemployment to a certain extent. Processing of millets by innovative methods without compromising their nutritional values paves the way for increased consumption of these grains at the global level.

GOAL 2: Zero Hunger

The hunger needs are directly proportional to the population growth. Extreme hunger and malnutrition remains a barrier to sustainable development. It is estimated that 840 million people will go hungry by 2030. The changing climatic conditions, pandemic, locust crisis, declining food production have all contributed to food scarcity. Investment in the agriculture sector, improving food security, creating employment and building resilience to disasters and shocks are all need of the hour to end hunger.[3] Minor millets such as finger, kodo, foxtail, little, proso and barnyard, have the ability to grow successfully in diverse soils, varying rainfall regimes, diverse photoperiods and in marginal, due to their genetic adaptation. These characteristics qualify the millets to replace commodities like wheat and rice in harsh climatic zones, eventually leading to food security in these areas.[5]

Millets abode for both macro and micronutrients, rich in bioactive compounds, better amino acid profile thus providing the much needed nutritional security.[4]

GOAL 3: Good Health and Well-being

The main polyphenols such as phenolic acids and tannins are found in abundance in millet and are believed to act as antioxidants and play a vital role in boosting the body's immune system. Antioxidants are known nutrients that help minimize free radical damage to the body, and also have anti-inflammatory activity. Furthermore, millet grains contain numerous flavonoids, comprising anthocynidins, chalcones, aminophenolics, favanols, favones, and favanones. The generous content of phenolic compounds in millet has made it a potent source of antioxidants.[6]

Noncommunicable diseases (NCDs) kill 41 million people each year, equivalent to 74% of all deaths globally. Each year, 17 million people die from a NCD before age 70; 86% of these premature deaths occur in low- and middle-income countries. Of all NCD deaths, 77% are in low- and middle-income countries. Cardiovascular diseases account for most NCD deaths, or 17.9 million people annually, followed by cancers (9.3 million), chronic respiratory diseases (4.1 million), and diabetes (2.0 million including kidney disease deaths caused by diabetes).[7]

Metabolic risk factors contribute to four key metabolic changes that increase the risk of NCDs:[7]

- Raised Blood Pressure;
- Overweight/Obesity;
- Hyperglycemia (High Blood Glucose Levels); And
- Hyperlipidemia (High Levels Of Fat In The Blood).

Millets in NCDs

Cardiovascular diseases: Protein concentrate of foxtail millet Elevated levels of adinopectin which protects cardiovascular tissues by: (1) Inhibition of pro-inflammatory and hypertrophic response (2) Stimulation of endothelial cell responses.[8] Administration of proso/ foxtail millet Reducing plasma triglycerides, LDL through improved cholesterol metabolism Lower C reactive protein: a marker of inflammation and a stronger predictor of cardiovascular events in clinical applications.[9]

Diabetes: Dietary fiber in millets Slow glucose release and low glycemic load.[10] Protein concentrates rich in antioxidants, Seed coat phenolics act as inhibitors which decrease postprandial hyperglycemia by blocking the action of complex carbohydrate hydrolyzing enzymes (amylase, alphaglucosidase); increase in adinopectin concentration may improve insulin sensitivity.[11]

Obesity Dietary fiber Controls release of carbohydrates Soluble fiber leads to highly viscous intestinal contents that possess gelling properties and could delay the intestinal absorption of carbohydrates Low glycemic index.[10]

Cancer Phenolic extracts from seven millet varieties (kodo, fingerproso, foxtail, little and pearl millet Inhibition of lipid peroxidation in liposomes, singlet oxygen quenching and inhibition of DNA scission Millet extracts inhibited H-29 cell proliferation in the range of 28–100% after 4 days of administration.[12] 35 kDa protein FMBP extracted from foxtail millet bran extract FMBP, homologous to peroxidase suppress colon cancer cell growth through: (1) Induction of G1 phase arrest (2) Loss of mitochondrial trans-membrane potential resulting in caspase-dependent apoptosis in colon cancer cells.[13]

Inflammation and wound healing Antioxidants: 50 g of finger millet per 100 g feed in diabetic and non-diabetic rats Enhances dermal wound healing process in diabetes with oxidative stress-mediated modulation of inflammation.[14] Administration of proso/ foxtail millet Lower C reactive protein.[15]

Ageing Antioxidant: Methanolic extract of finger millet Inhibit glycation and cross-linking of collagen Scavenge free radicals in protection against ageing.[16] Anti-microbial activity Protein extracts, polyphenols Anti-fungal and antibacterial activity: active against Bacillus cereus, Aspergillus niger.[17] Seed coat phenolic extract Loss of fungal functionality by: (1) Oxidation of microbial membranes and cell components by the free radicals (2) Inactivation of enzymes due to irreversible complex formation with nucleophilic amino acids (3) Complex formation of phenolic compounds with biopolymers such as proteins, polysaccharides and metal ions making them unavailable to micro-organisms.[18]

Ocular diseases and disorders Polyphenols, flavonoids: Wistar rats maintained on 5% finger millet seed coat matter (SCM) for 6 weeks (1) Direct scavenging of reactive oxygen species (ROS), anti-apoptotic activity, and phase 2 induction (2) Inhibiting nitric oxide (NO) production (3) Inhibiting certain enzymes responsible for the production of superoxide anions (xanthine oxidase and protein kinase C) (4) Prevents the accumulation of sorbitol by inhibiting aldose reductase by non-competitive inhibition and reduce the risk of diabetes-induced cataract diseases.[19,20]

Coeliac Disease Absence of gluten in millet protein prevents coeliac disease and related complications.[21]

GOAL 4: Quality Education

Over the past decade, major progress has been made towards increasing access to education and school enrollment rates at all levels, particularly for girls. Nevertheless, about 258 million children and youth were still out of school in 2018 — nearly one fifth of the global population in that age group.[3] Providing midday meals can be used an effective tool to increase the school enrollment in underdeveloped and developing countries. Millets can be used to replace the cereal grains in preparation of mid day meals as they are considerably affordable and the nutritional value also is secured to a very good extent.

GOAL 6: Clean Water and Sanitation

An increase in the areas of crops with intense water requirements like rice, sugarcane (Saccharum ofcinarum) and cotton (Gossypium) has resulted in the increase in 0.009% in the distance between the ground level and ground water table and this loss is approximately equivalent to a loss of 7191 L of ground water per hectare. There is a lesser possibility of increasing the production of major staple cereals as the world is already facing the challenges of increase in dry lands and deepening of ground water level.[22] According to the report of the National Rainfed Area Authority (NRAA) even after realizing the full irrigation potential, about half of the net sown area will continue to remain rainfed.[23] This alarms the need of shifting to the alternative of current cereal staples. Millets cultivation can be a solution to this problem as these can grow on shallow, low fertile soils with a pH of soil ranging from acidic 4.5 to basic soils with pH of 8.0.[24] Millets can be a good alternative to wheat especially on acidic soils. Rice is very sensitive to saline soils and has poor growth and yield on a soil having salinity higher than 3dS/m.[25] On the other hand, millets like pearl millet (Pennisetum glaucum) and finger millet can grow up to a soil salinity of 11–12 dS/m. Millets have a low water requirement both in terms of the growing period and overall water requirement during growth. The rainfall requirement of certain millets like pearl millet and proso millet (Panicum miliaceum) is as low as 20 cm, which is several folds lower than the rice, which requires an average rainfall of 120–140 cm. Most of the millets mature in 60–90 days after sowing which makes them a water saving crop. Barnyard millet (Echinochloa frumentacea) has the least maturation time of 45–70 days among millets, which is half to the rice maturation (120–140 days) time.[26] Millets fall under the group of C4 cereals. C4 cereals take more carbon dioxide from the atmosphere and convert it to oxygen, have high efficiency of water use, require low input and hence are more environment friendly. Thus, millets can help to phase out climatic uncertainties, reducing atmospheric carbon dioxide, and can contribute in mitigating the climate change.[4]

GOAL 8: Decent Work and Economic Growth

Millets can easily thrive in extreme conditions like drought, and some wild varieties can even prevail in flooded areas and swampy grounds which render them climate change compliant crops. These can not only serve as an income crop for farmers but also improve the health of the community as a whole because of their rich nutritional content. The cost of millet production is comparatively less than that of cereals like sorghum.

Local markets must be encouraged. The consumers should get access to grains directly from the local producers which aids in local economic growth.

GOAL 9: Industry, Innovation and Infrastructure

Micro-, Small- And Medium-Sized enterprises coming up with innovative ideas in production, processing of millets and delivering into present day consumable forms should be initiated. It will also provide a platform to create employment. Care should be taken to see that the modern processing ideas should not compromise the nutritional value of the crop.

The antinutritional components present in millets such as Phytates, trypsin inhibitors. Oxalates, Goitrogenic compounds pose a threat to consumption of millets. Therefore, the processing of millets by dehulling, milling, malting, blanching, parboiling, acid and heat treatments, and the fermentation help in reduction of these anti nutrients. But decortication, dehulling, milling, extrusion resulted in a reduction of total proteins, total dietary fibre, and micronutrients. Thus, care should be taken during the decortication of millets, as excessive dehulling can result in lower fibre content and loss of micronutrients due to the loss of nutrient-rich bran and germ portion.[27] New methodologies which inhibit these components without hampering the nutrients must be encouraged.

Public must be educated about the health benefits of millets consumption, the effect of processing on nutritional value of millets. Awareness of these definitely affect the consumption.

GOAL 10: Reduced Inequality

Minor/Smaller/Medium Sized Enterprises can be established for processing, production and sale of millet based foods. Special policies/ financial schemes may be offered to such enterprises particularly inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status. Example: Kudumbashree enterprises run in Kerala state.

GOAL 12: Responsible Consumption and Production

Millet production requires less usage of water, minimal pesticides. They can grow on shallow, low fertile soils with a pH of soil ranging from acidic 4.5 to basic soils with pH of 8.0. Millets have a low water requirement both in terms of the growing period and overall water requirement during growth. The rainfall requirement of certain millets like pearl millet and proso millet (Panicum miliaceum) is as low as 20 cm, which is several folds lower than the rice, which requires an average rainfall of 120–140 cm. Most of the millets mature in 60–90 days after sowing which makes them a water saving crop. Millets fall under the group of C4 cereals. C4 cereals take more carbon dioxide from the atmosphere and convert it to oxygen, have high efficiency of water use, require low input and hence are more environment friendly. Thus, millets can help to phase out climatic uncertainties, reducing atmospheric carbon dioxide, and can contribute in mitigating the climate change.[4]

GOAL 15: Life on Land

A study by has shown that whole pearl millet grain can be included in the broiler diet by up to 50% without it having a negative effect on performance. Another study by indicated that pearl millet varieties have produced comparable results to corn regarding metabolisable energy and digestible amino acids.[28] A study confirmed that the replacement of corn with pearl millet in broilers' diets has led to significant enhancements of growth and feed efficiency.[29] The replacement of corn with sorghum and millet by up to 50% of layers' diets, had similar effects on the egg production rate. Millet grain is also considered useful in replacement of maize in the big animals.[30]

GOAL 17: Partnerships to achieve the Goal

Special policies and financial aid should be provided to industries to prepare millet based products of good quality and export to other countries. Partnership from local markets to international markets to be strengthened to achieve this goal.

CONCLUSION

Millets, as a versatile and resilient crop, hold significant potential in contributing to the achievement of the United Nations' Sustainable Development Goals (SDGs). Their nutritional benefits, climate resilience, low water requirements, and adaptability to various growing conditions make them a critical tool in combating global challenges such as poverty, hunger, and poor health. By promoting millet cultivation and consumption, it is possible to improve food security, enhance public health, and support sustainable agricultural practices, all of which contribute to the broader goal of sustainable development.

Millets' ability to thrive in challenging climates offers a sustainable alternative to water-intensive crops like rice, while their rich nutritional profile addresses malnutrition and non-communicable diseases. Furthermore, millets can support local economies, improve livelihoods, and provide solutions to employment challenges, especially in rural areas. Their integration into modern food systems, through innovative processing methods, can increase consumption and make them more accessible globally.

The promotion of millet-based industries, educational initiatives about their health benefits, and supportive policies for local farmers and small enterprises will be key in unlocking the full potential of millets. By harnessing their multifaceted benefits, millets can significantly contribute to achieving the SDGs, ensuring a healthier, more sustainable, and equitable future for all.

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