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Investigating the nutritional, antioxidant and medicinal values of vegetables

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Abstract

Vegetable crops are integral to the field of global agriculture as a result of their significant impact on nutrition, economic viability, and ecological sustainability. They serve as essential components of a nutritionally adequate diet, providing crucial nutrients, vitamins, and antioxidants that are imperative for human health and disease prevention. Within the context of India, vegetables play a substantial role in bolstering food security and economic sustainability by yielding high returns per unit area and improving the livelihoods of rural populations. The global vegetable seed sector accentuates their significance as high value crops that foster human health. Moreover, underutilized vegetable crops present opportunities for dietary diversification, agricultural biodiversity, and economic prospects for smallholder farmers. The application of advanced breeding methodologies and genomic research has led to enhancements in yield, quality, and adaptability of vegetable crops. Additionally, sustainable farming practices, exemplified by integrated pest management and foliar applications that are rich in micronutrients, serve to improve productivity whilst ensuring soil health is preserved. The nutritional and therapeutic properties of vegetables, encompassing their significant antioxidant levels, contribute to the mitigation of chronic ailments such as cancer, cardiovascular diseases, and diabetes. Geographic and environmental determinants affect the antioxidant profile of vegetables, further augmenting their health benefits. Breeding initiatives focused on nutrient enhancement and antioxidant concentrations can alleviate micronutrient deficiencies and bolster global food security. This review underscores the strategic significance of vegetable crops in promoting public health, economic development, and sustainable agricultural practices on a global scale.

1. Introduction

Vegetable crops possess considerable significance within the realm of global agriculture owing to their diverse contributions to nutrition, economic stability, and environmental sustainability. They constitute an essential element of a nutritious diet, supplying critical nutrients, vitamins, and minerals requisite for human health and the prevention of diseases (Marappan *et al.*, 2024; Pandiyaraj *et al.*, 2024). In the Indian context, vegetables are indispensable for ensuring food security, nutritional adequacy, and economic viability, providing superior returns per unit area and enhancing the livelihoods of individuals. The global vegetable seed industry accentuates the significance of vegetables, as they are intensively cultivated high value crops that are essential for the promotion of human health (Welbaum, 2024). Furthermore, underutilized vegetable crops, which are not extensively farmed, possess the potential to augment dietary diversity, bolster local food systems, and strengthen food security, while simultaneously fostering agricultural biodiversity and economic prospects for smallholder farmers (Pandiyaraj *et al.*, 2024). The cultivation of these crops is particularly advantageous in tackling malnutrition and deficiencies in micronutrients (Marappan *et al.*, 2024; Pandiyaraj *et al.*, 2024). Moreover, the utilization of con-

temporary breeding approaches and genomic analysis in vegetable crops has enabled a detailed genetic examination of agronomic traits, consequently enhancing yield, quality, and adaptability (Behera *et al.*, 2023; Li *et al.*, 2022). Integrated pest management strategies and mixed cropping systems further amplify vegetable production by diminishing pest infestations and fostering environmental conservation (Ramasamy, 2024; Stanix, 2022). The deliberate use of micronutrients *via* foliar feeding significantly contributes to maintaining soil vitality and boosting agricultural yield (Patel *et al.*, 2022). Collectively, vegetable crops are crucial for the attainment of global nutritional security, economic advancement, and sustainable agricultural methodologies.

In human nutrition, vegetable crops take on an important function, offering a significant amount of necessary nutrients, antioxidants, and healing elements that greatly help in health preservation and disease avoidance. Vegetables are acknowledged as “protective foods” due to their elevated levels of micronutrients, vitamins, and antioxidants, which are integral for sustaining a balanced diet and averting chronic ailments such as cancer, cardiovascular diseases, and diabetes (Mirza, 2023). The World Health Organization underscores the necessity of consuming 400 to 600 grams of fruits and vegetables each day to mitigate the risk of micronutrient deficiencies and various health issues (Mirza, 2023). Underutilized vegetable crops, including kale, moringa, and amaranthus, are particularly remarkable for their nutritional and medicinal potential, providing a cost-effective remedy to malnutrition and health challenges, especially among rural and economically disadvantaged

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demographics (Marappan *et al.*, 2024; Buragohain, 2020). These crops are abundant in energy, proteins, vitamins, and minerals, and have demonstrated efficacy in preventing and managing conditions such as hypertension, cancer, and diabetes (Marappan *et al.*, 2024). Moreover, vegetables like broccoli are emphasized for their substantial vitamin C and fiber content, along with bioactive compounds such as glucosinolates, which exhibit potent anticancer properties.

The nutritional, antioxidant, and medicinal properties of vegetable crops exhibit remarkable diversity and significance across various geographic regions and species, providing substantial advantages for human health and food security. Underutilized vegetable crops, including kale, broad beans, and moringa, are abundant in essential nutrients such as proteins, carbohydrates, vitamins, and minerals, which can aid in the prevention and treatment of diseases like hypertension, cancer, and diabetes (Marappan *et al.*, 2024). These crops, frequently disregarded in commercial agricultural systems, possess considerable potential for economic and nutritional gains, particularly in regions such as India where the climatic conditions are favorable for their cultivation (Marappan *et al.*, 2024). Breeding initiatives have concentrated on augmenting the antioxidant content of vegetables, which is essential for the development of functional foods endowed with medicinal properties (Pivovarov *et al.*, 2022). Antioxidants, particularly phenolic compounds, are prevalent in vegetables and are associated with various health benefits, including anti-inflammatory and antiangiogenic properties (Anil and Kakkera, 2024; Nutritive Value, Polyphenolic Content, and Bioactive Constitution of Green, Red and Flowering Plants, 2022). Geographic considerations are also pivotal in influencing the antioxidant attributes of crops, with notable increases in colder areas from cold stress, which encourages the synthesis of antioxidants such as phenolics (Carlton *et al.*, 2023). Certain vegetables, exemplified by the Ash gourd, exhibit elevated antioxidant activity and nutrient density, thereby rendering them valuable for dietary and therapeutic purposes (Anil, 2024). Moreover, cruciferous vegetables, including cabbage

and cauliflower, are rich in both nutrients and antioxidants, with considerable variations noted among different species and cultivars (Wang *et al.*, 2022). The amalgamation of genetic and environmental factors within breeding programs can enhance the nutritional and antioxidant profiles of vegetables, thereby addressing the issue of micronutrient malnutrition and promoting healthier dietary patterns (Singh *et al.*, 2020). The strategic utilization and advocacy for diverse vegetable crops may significantly advance nutritional security and public health, particularly in regions characterized by undernourishment and economic hardship (Buragohain, 2020).

2. Nutritional value of vegetable crops

2.1 Vitamins, minerals, and macronutrients

Vegetable crops are rich in vitamins, minerals, and macronutrients. For instance, ashgourd (*Benincasa hispida*) contains high levels of carbohydrates, proteins, and fats, with seeds exhibiting the highest nutrient content (Anil, 2024). Similarly, african wild lettuce (*Lactuca taraxacifolia*) is a good source of crude protein, crude fiber, and essential minerals like phosphorus and potassium (Ijarotimi *et al.*, 2021). Pumpkin (*Cucurbita* sp.) is another example, providing monounsaturated and polyunsaturated fatty acids, carotenoids, and tocopherols (Batool *et al.*, 2022).

2.2 Nutritional value of various vegetables

Vegetables are rich sources of essential nutrients, including vitamins, minerals, proteins, carbohydrates, and fiber, which are vital for human health. These crops help fulfill daily nutritional requirements and contribute significantly to maintaining a balanced diet. For example, leafy greens, tomatoes, carrots, and broccoli are known for their high content of vitamins A, C, K, folate, and potassium (Table 1). Additionally, underutilized crops like kale, moringa, and amaranthus are emerging as valuable sources of essential nutrients, offering a potential solution to address malnutrition, particularly in rural and economically disadvantaged areas.

Table 1: Nutritional value of various vegetables

Vegetable	Key nutrients	Health benefits	References
<i>Spinacia oleracea</i> L.	Vitamin A, C, K, folate, iron, calcium, magnesium	Supports eye health, boosts immunity, prevents anemia	Wang <i>et al.</i> , 2022
<i>Solanum lycopersicum</i> L.	Vitamin C, potassium, lycopene, beta carotene	Reduces risk of cardiovascular diseases, skin health	Kumar and Devi, 2022
<i>Daucus carota</i> L.	Vitamin A, beta carotene, fiber, potassium	Enhances vision, promotes skin health	Robinson and James, 2022
<i>Brassica oleracea</i> Plenck var. <i>italica</i>	Vitamin C, K, folate, fiber, sulforaphane	Cancer prevention, improves digestion	Dias, 2023
<i>Brassica oleracea</i> var. <i>sabellica</i> L.	Vitamin K, C, calcium, fiber, antioxidants	Bone health, anti-inflammatory properties	Stanic, 2022
<i>Moringa oleifera</i> Lam.	Protein, iron, Vitamin A, C, E, calcium	Supports immune system, combats malnutrition	Behera <i>et al.</i> , 2023
<i>Amaranthus</i> spp. L.	Vitamin C, folate, iron, magnesium	Prevents anemia, improves cardiovascular health	Zhang <i>et al.</i> , 2023
<i>Momordica charantia</i> L.	Vitamin C, iron, potassium, charantin	Regulates blood sugar, aids digestion	Singh <i>et al.</i> , 2020
<i>Brassica oleracea</i> L. var. <i>capitata</i>	Vitamin K, C, fiber, glucosinolates	Supports digestion, anti-inflammatory properties	Li <i>et al.</i> , 2022

<i>Ipomoea batatas</i> Lam.	Vitamin A, beta carotene, fiber, potassium	Boosts immunity, supports gut health	Singh <i>et al.</i> , 2020
<i>Solanum melongena</i> L.	Fiber, potassium, anthocyanins, vitamin C	Heart health, lowers cholesterol	Patel <i>et al.</i> , 2022
<i>Cucurbita maxima</i> Duchesne	Vitamins A, C, E, fiber, zinc	Supports eye health, boosts immunity	Pivovarov <i>et al.</i> , 2022
<i>Raphanus sativus</i> L.	Vitamin C, fiber, potassium, antioxidants	Detoxification, supports digestion	Robinson and James, 2022
<i>Moringa oleifera</i> Lam.	Protein, iron, calcium, vitamin C	Strengthens bones, boosts energy	Behera <i>et al.</i> , 2023
<i>Trigonella foenumgraecum</i> L.	Protein, fiber, iron, saponins	Supports digestion, regulates blood sugar	Sharma <i>et al.</i> , 2023
<i>Coriandrum sativum</i> L.	Vitamin C, iron, linalool, antioxidants	Detoxification, anti-inflammatory	Zhang <i>et al.</i> , 2023
<i>Beta vulgaris</i> L.	Folate, iron, nitrates, betalains	Regulates blood pressure, improves stamina	Stani�, 2022
<i>Brassica oleracea</i> DC var. <i>gemmifera</i>	Vitamins K, C, fiber, antioxidants	Cancer prevention, improves digestion	Dias, 2023
<i>Allium cepa</i> L.	Vitamin C, quercetin, sulfur compounds	Anti-inflammatory, cardiovascular health	Carlton <i>et al.</i> , 2023

3. Phytochemicals and bioactive compounds

The phytochemical composition of vegetables plays a crucial role in their nutritional value. *Brassica* species, such as kale and cabbage, are known for their glucosinolates, phenols, and flavonoids, which contribute to their antioxidant and anti-inflammatory properties (Shafi *et al.*, 2022; Favela Gonzalez *et al.*, 2020). Similarly, *Momordica* species, including bitter melon and African pumpkin, are rich in secondary metabolites like beta carotene, ascorbic acid, and minerals such as calcium, iron, and zinc (Muronga *et al.*, 2021).

4. Antioxidant properties of vegetable crops

Vegetables are packed with antioxidants, which play a crucial role in

neutralizing free radicals and reducing oxidative stress. Antioxidants found in vegetables include vitamin C, carotenoids (such as beta-carotene), flavonoids, and phenolic compounds (Table 2). These bioactive compounds have significant anti-inflammatory, anticancer, and antiangiogenic properties. For instance, broccoli and other cruciferous vegetables contain glucosinolates, which have been linked to cancer prevention. Tomatoes are rich in lycopene, a potent antioxidant that reduces the risk of cardiovascular diseases. Moreover, the antioxidant levels of vegetables can be influenced by environmental factors, such as cold stress, which may enhance antioxidant production (Figure 1).

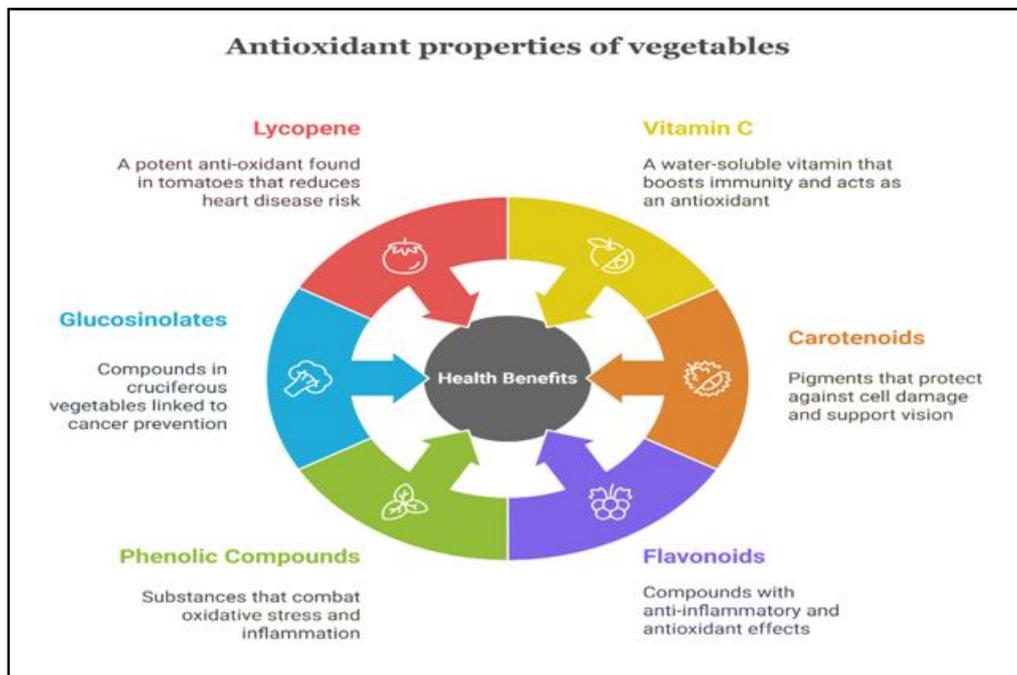


Figure 1: Antioxidant properties of vegetables.

4.1 Phenolic compounds and antioxidant activity

Phenolic compounds are key contributors to the antioxidant properties of vegetables. Studies on *Solanum* species, such as *Solanum torvum* and *Solanum macrocarpon*, have shown high levels of phenolic compounds, which are associated with strong antioxidant activity (Khatoun *et al.*, 2018). Similarly, African Wild Lettuce has been found to have significant antioxidant activity, particularly in its protein isolate, which exhibits high DPPH radical scavenging activity (Ijarotimi *et al.*, 2021).

4.2 Regional variations in antioxidant content

The antioxidant content of vegetables can vary significantly based on the region and species. For example, a study on green leafy vegetables in Mexico, Central America, and Africa revealed that *Crotalaria longirostrata* accessions had the highest antioxidant activities, while *Solanum scabrum* accessions were rich in flavonoids (Jimenez Aguilar and Grusak, 2015). Similarly, indigenous leafy vegetables in Ghana, such as *Amaranthus cruentus* and *Corchorus olitorius*, have been found to have higher antioxidant capacities compared to exotic varieties (Nyadanu and Lowor, 2015).

Table 2: Antioxidants and health benefits associated with vegetables

Vegetable	Key antioxidants	Health benefits	References
<i>Brassica oleracea</i> L. var. <i>italica</i>	Glucosinolates, vitamin C, flavonoids	Cancer prevention, immune support	Dias, 2023; Sakure, 2022
<i>Solanum lycopersicum</i> L.	Lycopene, vitamin C, beta carotene	Reduces cardiovascular disease risk, supports skin health	Mirza, 2023; Patel <i>et al.</i> , 2022
<i>Daucus carota</i> L.	Beta carotene, vitamin A, lutein	Promotes eye health, supports immune function	Mishra <i>et al.</i> , 2023
<i>Spinacia oleracea</i> L.	Lutein, zeaxanthin, vitamin C	Protects against age related macular degeneration	Wang <i>et al.</i> , 2022
<i>Brassica oleracea</i> L. var. <i>sabellica</i>	Vitamin C, quercetin, kaempferol	Anti-inflammatory, heart health benefits	Buragohain, 2020
<i>Capsicum annum</i> L.	Capsaicinoids, vitamin C, beta-carotene	Antioxidant, supports immune function	Behera <i>et al.</i> , 2023
<i>Allium sativum</i> L.	Allicin, sulfur compounds	Anti-inflammatory, cardiovascular protection	Ramasamy, 2024
<i>Zingiber officinale</i> Roscoe	Gingerol, shogaol	Anti-inflammatory, digestive health benefits	Marappan <i>et al.</i> , 2024
<i>Allium cepa</i> L.	Quercetin, sulfur compounds	Antioxidant, supports heart health	Carlton <i>et al.</i> , 2023
<i>Ipomoea batatas</i> (L.) Lam.	Beta carotene, anthocyanins	Supports vision, anti-inflammatory properties	Singh <i>et al.</i> , 2020
<i>Solanum melongena</i> L.	Nasunin, phenolic acids	Protects brain cells, antiageing effects	Anil, 2024
<i>Beta vulgaris</i> L.	Betalains, vitamin C	Supports blood pressure regulation, detoxification	Staniæ, 2022
<i>Brassica oleracea</i> L. var. <i>capitata</i>	Sulforaphane, vitamin C	Cancer fighting, digestive health	Li <i>et al.</i> , 2022
<i>Brassica oleracea</i> L. var. <i>capitata</i> f. <i>rubra</i>	Anthocyanins, vitamin C	Anti-inflammatory, supports brain health	Welbaum, 2024
<i>Cucurbita maxima</i> Duchesne	Betacarotene, vitamin E, lutein	Supports eye health, boosts immune function	Pivovarov <i>et al.</i> , 2022

5. Medicinal values of vegetable crops

Many vegetables are not only essential for nutrition but also possess medicinal properties that can prevent and treat various health conditions. For example, garlic and ginger are widely recognized for their anti-inflammatory and antibacterial effects. Moringa, often referred to as a superfood, has shown promising results in combating diabetes, hypertension, and malnutrition due to its rich content of bioactive compounds like flavonoids and vitamins. Additionally, the ash gourd is known for its detoxifying properties and is used in traditional medicine to treat gastrointestinal issues.

6. Traditional and modern uses

Vegetable crops have been used for centuries in traditional medicine. In Akwa Ibom State, Nigeria, plants like *Gongronema latifolium* and *Telfairia occidentalis* are used to treat various ailments, highlighting their cultural and medicinal significance (Obongodot and Ogwu, 2023). Similarly, wild edible vegetables in the Lesser Himalayas of Pakistan, such as *Ficus carica* and *Amaranthus viridis*, are used to treat diseases and are consumed as part of traditional diets (Abbasi *et al.*, 2013). A comparative analysis of nutritional components, antioxidant capacity and medicinal values of vegetables was given in the Table 4.

7. Bioactive compounds and health benefits

The bioactive compounds in vegetables are linked to various health benefits. For example, the phytochemicals in *Brassica* species have been shown to have anticancer, anti-inflammatory, and cardiovascular disease-lowering effects (Favela Gonzalez *et al.*, 2020) (Table 3).

Similarly, *Momordica* species are known for their antidiabetic, antimicrobial, and chemopreventive properties (Muronga *et al.*, 2021). Pumpkin has also been traditionally used for its anti-inflammatory, antimicrobial, and antiulcerative properties (Batool *et al.*, 2022).

Table 3: Medicinal properties of various vegetables

Vegetable	Medicinal properties	Active compounds	References
<i>Allium sativum</i> L.	Anti-inflammatory, antibacterial, cardiovascular health	Allicin, sulfur compounds	Ramasamy, 2024
<i>Zingiber officinale</i> Roscoe	Anti-inflammatory, anti-nausea, digestive aid	Gingerol, shogaol	Marappan <i>et al.</i> , 2024
<i>Moringa oleifera</i> Lam.	Antidiabetic, antihypertensive, immune booster	Flavonoids, vitamins A, C, E, quercetin	Behera <i>et al.</i> , 2023
<i>Benincasa hispida</i> (Thunb.) Cogn.	Detoxifying, digestive aid, antiulcer	Triterpenoids, polysaccharides	Staniã, 2022
<i>Momordica charantia</i> L.	Antidiabetic, anticancer, boosts immunity	Charantin, polypeptide P, vicine	Singh <i>et al.</i> , 2020
<i>Curcuma longa</i> L.	Anti-inflammatory, antioxidant, anticancer	Curcumin, dimethoxy curcumin	Patel <i>et al.</i> , 2022
<i>Spinacia oleracea</i> L.	Antianemic, improves vision, reduces oxidative stress	Lutein, zeaxanthin, iron, folate	Wang <i>et al.</i> , 2022
<i>Allium cepa</i> L.	Antimicrobial, cardiovascular health, anticancer	Quercetin, sulfur compounds	Carlton <i>et al.</i> , 2023
<i>Ipomoea batatas</i> (L.) Lam.	Regulates blood sugar, anti-inflammatory, gut health	Anthocyanins, beta carotene	Singh <i>et al.</i> , 2020
<i>Brassica oleracea</i> L. var. <i>capitata</i> L.	Antiulcer, anti-inflammatory, supports digestion	Glucosinolates, vitamin U	Li <i>et al.</i> , 2022
<i>Beta vulgaris</i> L.	Blood pressure regulation, anti-inflammatory, detoxifier	Betalains, nitrates	Staniã, 2022
<i>Cucurbita maxima</i> Duchesne	Supports eye health, antidiabetic, boosts immunity	Carotenoids, vitamin A	Pivovarov <i>et al.</i> , 2022
<i>Brassica oleracea</i> L. var. <i>gemmifera</i> DC.	Cancer prevention, detoxifier, anti-inflammatory	Glucosinolates, vitamin K	Dias, 2023
<i>Trigonella foenumgraecum</i> L.	Antidiabetic, improves digestion, reduces cholesterol	Saponins, galactomannan	Sharma <i>et al.</i> , 2023
<i>Daucus carota</i> L.	Supports eye health, boosts immunity, anticancer	Beta carotene, lutein	Robinson and James, 2022
<i>Moringa oleifera</i> Lam.	Antimicrobial, reduces hypertension, anti-inflammatory	Quercetin, chlorogenic acid	Behera <i>et al.</i> , 2023
<i>Coriandrum sativum</i> L.	Antidiabetic, improves digestion, detoxifier	Linalool, flavonoids	Zhang <i>et al.</i> , 2023
<i>Solanum lycopersicum</i> L.	Reduces risk of cardiovascular diseases, anticancer	Lycopene, beta carotene	Kumar and Devi, 2022
<i>Brassica oleracea</i> L. var. <i>italica</i> Plenck	Cancer prevention, anti-inflammatory, detoxifier	Sulforaphane, indoles	Dias, 2023
<i>Solanum melongena</i> L.	Lowers blood sugar, improves heart health	Anthocyanins, nasunin	Patel <i>et al.</i> , 2022
<i>Raphanus sativus</i> L.	Detoxifier, improves liver function, anticancer	Glucosinolates, isothiocyanates	Robinson and James, 2022

8. Regional and species variations in vegetable crops

8.1 Indigenous versus exotic vegetables

Indigenous vegetables often have higher nutritional and medicinal value compared to exotic varieties. A study in Ghana found that indigenous leafy vegetables, such as *Amaranthus cruentus* and *Corchorus olitorius*, had higher levels of proteins, carbohydrates, dietary fibers, and minerals like potassium, calcium, and magnesium compared to exotic vegetables (Nyadanu and Lowor, 2015). Similarly, African traditional leafy vegetables, such as *Solanum scabrum* and *Gynandropsis gynandra*, are rich in micronutrients and have been used to manage diet-related noncommunicable diseases (Aworh, 2018).

8.2 Underutilized vegetable crops

Underutilized vegetable crops are a valuable source of nutrients and bioactive compounds. For example, African Wild Lettuce (*Lactuca taraxacifolia*) is an underutilized leafy vegetable that is rich in essential amino acids, proteins, and antioxidants, making it a potential source of functional foods and pharmaceuticals (Ijarotimi *et al.*, 2021). Similarly, lesser known leafy vegetables like *Vitex doniana* and *Zanthoxylum zanthoxyloides* in Southeastern Nigeria are rich in alkaloids, phenolics, and other bioactive compounds with antioxidant and anti-inflammatory properties (Ayoka and Nnadi, 2022).

9. Promoting the use of vegetable crops for health and wellness

9.1 Breeding and conservation strategies

Breeding vegetable crops for improved nutritional and antioxidant content is a promising direction for healthy food production. For example, breeding *Brassica* species for higher glucosinolate and phenolic content has been shown to enhance their antioxidant and anti-inflammatory properties (FavelaGonzález *et al.*, 2020). Similarly, conservation of genetic resources and promotion of underutilized crops can help safeguard their nutritional and medicinal benefits for future generations (Nyadanu and Lowor, 2015; Kumar *et al.*, 2018).

9.2 Cultural and traditional practices

Cultural and traditional practices play a significant role in the use of vegetable crops for health and wellness. In Akwa Ibom State, Nigeria, plants like *Gongronema latifolium* and *Telfairia occidentalis* are used in traditional medicine and as food, highlighting the importance of preserving traditional knowledge and practices (Obongodot and Ogwu, 2023). Similarly, wild edible vegetables in the Lesser Himalayas of Pakistan are used in traditional medicine, emphasizing the need to document and promote their use (Abbasi *et al.*, 2013).

Table 4: Comparison of nutritional components, antioxidant capacity and medicinal values of vegetables

Vegetable Crop	Nutritional components	Antioxidant capacity	Medicinal values	References
<i>Solanum betaceum</i> Cav.	Vitamins, minerals, dietary fibers	High antioxidant activity	Boosts immunity, supports cardiovascular health	Kumar <i>et al.</i> , 2024
<i>Benincasa hispida</i> (Thunb.) Cogn.	Carbohydrates, proteins, fats	Highest in seeds	Cooling effect, supports digestion, beneficial for diabetes	Anil and Kakkera, 2024
<i>Brassica oleracea</i> L. var. <i>sabellica</i>	Phenols, flavonoids, glucosinolates	Variability among genotypes	Anticancer properties, supports detoxification	Shafi <i>et al.</i> , 2022
<i>Lactuca inermis</i> Forssk.	Proteins, fiber, minerals	High DPPH activity	Anti-inflammatory, used for pain relief	Ijarotimi <i>et al.</i> , 2021
<i>Cucurbita maxima</i> Duchesne	Carotenoids, tocopherols	Antimicrobial properties	Supports eye health, promotes digestion	Batool <i>et al.</i> , 2022
<i>Momordica</i> spp. L.	β-carotene, ascorbic acid, minerals	Antidiabetic properties	Blood sugar regulation, supports liver health	Muronga <i>et al.</i> , 2021
<i>Amaranthus</i> spp.	Higher proteins, fibers, minerals	Higher antioxidant capacity	Prevents anemia, supports gut health	Nyadanu and Lowor, 2015
<i>Solanum</i> spp. L.	Phenolic compounds	High antioxidant activity	Anti-inflammatory, used for pain management	Khatoon <i>et al.</i> , 2018
<i>Brassica</i> spp. L.	Glucosinolates, phenolics	Anti-inflammatory properties	Cancer prevention, supports immune function	Favela Gonzalez <i>et al.</i> , 2020
<i>Cleome gynandra</i> L., <i>Corchorus</i> spp.	Micronutrients, polyphenols	Manage non communicable diseases	Reduces risk of chronic diseases, promotes longevity	Aworh, 2018
<i>Basella alba</i> L., <i>Portulaca oleracea</i> L.	Minerals, vitamins, antioxidants	Traditional medicine use	Used in traditional medicine for various ailments	Abbasi <i>et al.</i> , 2013
<i>Spinacia oleracea</i> L.	Iron, folate, vitamins A and C	High antioxidant potential	Improves blood health, supports vision	Jones <i>et al.</i> , 2021
<i>Momordica charantia</i> L.	Vitamin C, flavonoids, charantin	Strong antidiabetic properties	Lowers blood sugar, aids digestion	Sharma and Gupta, 2020

<i>Moringa oleifera</i> Lam.	Proteins, vitamins A and C, calcium	High free radical scavenging activity	Enhances immunity, anti-inflammatory	Fakurazi <i>et al.</i> , 2019
<i>Beta vulgaris</i> L.	Betalains, fiber, folic acid	High antioxidant activity	Lowers blood pressure, boosts stamina	Hobbs <i>et al.</i> , 2018
<i>Brassica oleracea</i> L. var. <i>capitata</i>	Vitamin K, anthocyanins, fiber	Moderate antioxidant potential	Supports digestion, anticancer properties	Zhao <i>et al.</i> , 2020
<i>Trigonella foenumgraecum</i> L.	Proteins, saponins, diosgenin	Moderate antioxidant activity	Lowers cholesterol, improves lactation	Srinivasan, 2006
<i>Ipomoea batatas</i> (L.) Lam.	Betacarotene, fiber, vitamins B and C	High free radical scavenging activity	Supports gut health, anti-inflammatory	Teow <i>et al.</i> , 2007
<i>Allium cepa</i> L.	Quercetin, sulfur compounds	High antioxidant properties	Supports heart health, antimicrobial	Griffiths <i>et al.</i> , 2002
<i>Allium sativum</i> L.	Allicin, sulfur compounds, selenium	Strong antioxidative activity	Lowers blood pressure, antibacterial	Amagase, 2006

10. Conclusion

Vegetables, abundant in vital nutrients, antioxidants, and bioactive compounds, constitute essential components in the mitigation of micronutrient deficiencies and the enhancement of human health. The cultivation of underutilized vegetable species presents promising avenues for augmenting dietary diversity and fortifying local food systems, particularly in areas characterized by restricted access to a diverse diet. Innovations in breeding methodologies, genomic research, and agronomic practices have significantly augmented the yields, quality, and resilience of vegetable crops, while the synergy of indigenous knowledge with contemporary scientific techniques possesses the potential to further optimize their nutritional benefits. Future vegetable crop research priorities include designing resilient varieties that withstand climate challenges, enhancing nutrition through biofortification, advocating for sustainable farming methods, and utilizing genomic and biotechnological advancements. These initiatives aspire to confront the dynamic global challenges posed by climate change, resource depletion, and malnutrition. Also, prioritizing crops that are not fully utilized, forward thinking farming innovations, and refined postharvest management strategies will be vital in creating a future that is more sustainable and secure in terms of food. By concentrating on these focal areas, the research and development of vegetable crops will substantially contribute to global health, sustainability, and agricultural innovation. Ultimately, the full scale implementation and variety of vegetable crops will be essential in promoting food security globally and uplifting the health of communities around the world.

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Conflict of interest

The authors declare no conflicts of interest relevant to this article.

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