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Indigenous African wild food plants as vital iron sources in conflict settings

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ABSTRACT

Armed conflicts and displacement across sub-Saharan Africa are intensifying food insecurity and nutritional deficiencies among vulnerable populations, with anaemia affecting a substantial proportion of women and children in the region. Millions of internally displaced persons (IDPs) depend on locally available natural resources for survival, particularly wild food plants collected from forests and surrounding landscapes. Indigenous African wild food plants represent an important yet often overlooked component of forest biodiversity that contributes to food security and human health.

In conflict-affected settings, traditional ethnobotanical knowledge enables communities to identify, harvest, and prepare edible wild species that can supplement limited food supplies and provide essential micronutrients. Several wild plant species reported in the literature contain high levels of iron, in some cases exceeding those of commonly consumed staple foods. However, the nutritional contribution of these species depends not only on iron content but also on bioavailability and dietary utilization.

This perspective highlights the potential role of iron-rich indigenous wild food plants in supporting nutrition among displaced populations in sub-Saharan Africa. We discuss the relevance of traditional knowledge, ecological availability, importance of appropriate processing methods that enhance iron bioavailability, and integrating wild food plants into humanitarian and nutrition strategies in conflict settings. We further emphasize the need to document indigenous knowledge, conserve biodiversity, and integrate wild food plants into nutrition-sensitive humanitarian strategies to support resilient food systems in crisis-affected regions.

1. Introduction

Between 638 and 720 million people faced hunger in 2025, including approximately 307 million in Africa (FAO, IFAD, UNICEF, WFP and WHO, 2025). Despite global efforts, no significant progress has been made in reducing hunger on the continent, where food insecurity remains alarmingly high. Food insecurity is escalating across Sub-Saharan Africa (SSA) countries (Otekunrin, 2025). The number of people unable to afford a healthy diet rose by 23.9 million to 842.9 million between 2021 and 2022. In 2025, a substantial proportion of the population lacking economic access to a healthy diet was concentrated in Eastern Africa (348.6 million) and Western Africa (297.5 million), representing the largest regional shares. Due to ongoing civil war and conflicts, nearly 282 million people faced high levels of acute food insecurity in the 59 food-crisis countries in 2025 (FSIN and GNAFC, 2025). The five African countries with the largest numbers of people facing high levels of acute food insecurity were, in descending order, the Democratic Republic of the Congo, Nigeria, Sudan, Ethiopia and South Sudan. There are 75.9 million internally displaced persons (IDPs) worldwide, most of them are in Africa (IDMC, 2025). Conflicts in Sudan and the Democratic Republic of the Congo (DRC) accounted for nearly half of conflict movements in 2025, it has been estimated as 11.6 million in Sudan and 6 million in DRC (Fig. 1). Many governments are unable to exercise power beyond a few miles outside of the capitals to undertake measures to properly feed IDPs. For IDPs, survival amidst civil war, conflicts and severe famine depends mainly on the wild food plants which are locally available. IDPs can turn towards ethnobotanical knowledge to secure their food demands from the surrounding environment by consuming wild food plant resources (Sulaiman et al., 2022). Consuming indigenous wild food plants becomes a first coping mechanism for IDPs. The use of wild food plants can have great impact on survival of the African IDPs during conflicts. The utilization of these plants requires specific ethnobotanical

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knowledge, including traditional methods of food preparation and consumption, as well as documentation of their seasonal availability, regional distribution, processing techniques, and sustainability. Their nutritional value may be further enhanced through the inclusion of iron absorption enhancers, complementary nutrients, vitamins, and other health-promoting secondary compounds. Moreover, there is a genetic basis for iron absorption in humans, and emerging evidence suggests genetic variation in iron utilization efficiency among populations from different African regions, underscoring the need for context-specific nutritional interventions (Kang et al., 2021).

This perspective is informed by a targeted narrative synthesis of the literature and builds on the authors' prior documentation on iron-rich plant species. Relevant studies were identified through focused keyword searches and selected based on criteria including reported iron content, traditional use, geographical distribution, and relevance to food security in African contexts. The selected species were chosen as representative examples due to their high iron content, ecological adaptability, and cultural relevance in regions affected by displacement.

2. Living situations of IDPs due to ongoing conflicts in Africa

Internally displaced persons (IDPs) are individuals forced to flee their homes due to conflict, violence, or disasters without crossing internationally recognized borders, remaining within their own country. They often face severe housing insecurity, limited access to food and healthcare, and unstable living conditions, all of which negatively affect their health status. As a result, IDPs experience a high burden of malnutrition and are at increased risk of both infectious and non-communicable diseases, including cardiovascular disease, diabetes, and liver disease, as well as malnutrition-related conditions such as kwashiorkor, marasmus, and anaemia (Cantor et al., 2021; Teketelew et al., 2023; Davidson et al., 2022).

Uprooted from their homes and livelihoods, IDPs are among the most vulnerable populations globally, with many experiencing prolonged displacement lasting years or even decades. This situation is exemplified by the ongoing conflict in Sudan, which began in April 2023 between the Sudanese Armed Forces (SAF) and the Rapid Support Forces (RSF). The conflict has displaced approximately 8.25 million people, with 24.8 million in need of humanitarian assistance and 17.7 million facing acute food insecurity, highlighting the scale and severity of the crisis (Siddig and Basheer, 2024).

The map illustrates the estimated number of people internally displaced due to conflict across sub-Saharan African countries in 2025. The shading intensity represents the relative scale of displacement, with darker colours indicating higher numbers of IDPs. Countries with no available data are shown in grey. Data highlight regions experiencing severe humanitarian crises, particularly in parts of Sudan and the Democratic Republic of the Congo. https://www.internaldisplacement.org/database/displacement-data/

3. Prevalence of anemia in African IDP camps

Internally displaced persons (IDPs) face prolonged housing insecurity, food shortages, limited healthcare access, and chronic instability, all of which contribute to a high burden of malnutrition and disease (Davidson et al., 2022). IDPs are at increased risk of communicable diseases (e.g., tuberculosis, HIV), vector-borne diseases (e.g., malaria, leishmaniasis), vaccine-preventable illnesses (e.g., measles, influenza), and non-communicable diseases (e.g., cardiovascular disease, diabetes), as well as malnutrition-related conditions including kwashiorkor, marasmus, and anaemia (Cantor et al., 2021; Teketelew et al., 2023). Among these, anaemia is one of the most prevalent and persistent conditions in displacement settings Table 1. The highest pooled prevalence of anaemia among refugee children has been reported in Africa, reaching 56.1%. Among pregnant women, anaemia prevalence varies across settings: 44.4% in IDP camps in Mogadishu, Somalia (Ahmed et al., 2021); 36.1% among South Sudanese refugees in Pugnido, western Ethiopia (Alemayehu et al., 2016); 36.3% among South Sudanese refugees in Uganda (Bongomin et al., 2025); and 27.9% in southeast

Table 1
Anaemia prevalence reported in African IDP and refugee populations.

Location/ Country	Group	Anaemia prevalence %	References
Ntele Camp, Mozambique	Children under five	83.0	Aly et al., 2025
Mogadishu, Somalia	Pregnant women	44.4	Ahmed et al., 2021
Pugnido, Ethiopia	Pregnant women	36.1	Alemayehu et al., 2016
West Nile, Uganda	Pregnant women	36.3	Bongomin et al., 2025
Southeast Ethiopia	Pregnant women	27.9	Kefiyalew et al., 2014

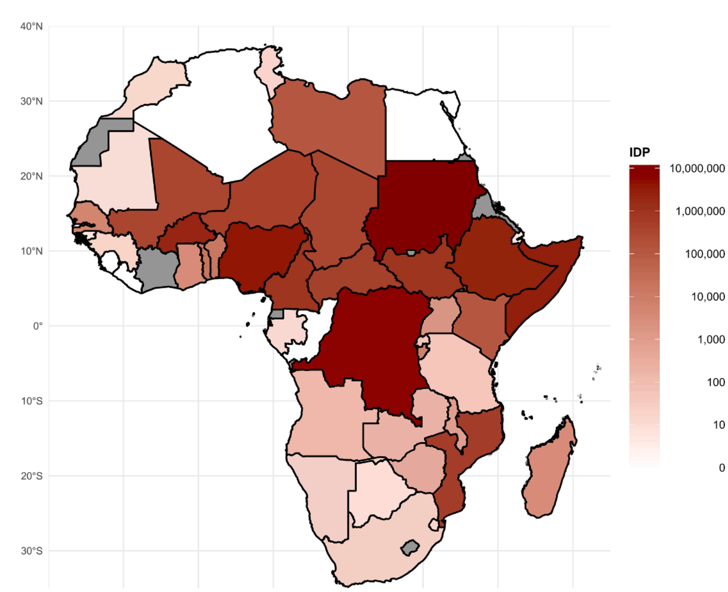

Fig. 1. Conflict-related internally displaced persons (IDPs) in sub-Saharan Africa, 2025.

Ethiopia (Kefiyalew et al., 2014). Anaemia is even more pronounced in young children, with rates as high as 83% reported among children under five years of age in the Ntele IDP camp in Cabo Delgado, Mozambique (Aly et al., 2025). These consistently high prevalence rates exceeding 80% in some child populations and 35–45% in pregnant women underscore the urgency of identifying accessible, nutrition-sensitive strategies. The use of locally available wild food plants to improve iron intake represents one such strategy, particularly given the limitations of fortified food distribution in conflict settings (Tuyizere et al., 2021).

4. Dietary implications: meeting the RDA with wild food plants versus cereals

Iron-deficiency anaemia (IDA) remains one of the most widespread micronutrient deficiencies in Africa (Manu et al., 2026), largely due to the limited bioavailable iron content in staple diets dominated by cereals such as wheat, maize, millet, and sorghum. Although these cereals are critical sources of calories and macronutrients, their iron concentrations are generally low (Table 1). Moreover, high levels of phytates and polyphenols in cereal grains substantially inhibit iron absorption, with fractional absorption rates often below 5%. Consequently, meeting the Recommended Daily Allowance (RDA) for iron (7 mg/day for children, 27 mg/day for pregnant women) through cereal-based diets alone would require impractically large quantities of food. For example, the amount of millet or maize needed to meet the daily iron needs of a pregnant woman exceeds 300–450 g of dry grain - a physiologically unrealistic intake, especially in populations with limited dietary diversity.

In contrast, several indigenous African wild food plants exhibit iron concentrations substantially higher than those of cereals. Species such as *Parinari curatellifolia, Balanites aegyptiaca*, and *Grewia tenax* combine high iron content with wide distribution across sub-Saharan Africa, established traditional use, local acceptance, and strong ecological resilience in arid and semi-arid environments where internally displaced populations are often concentrated. These attributes make them well-documented, accessible, and scalable candidates for nutritional interventions. As shown in Table 2, only a few grams of these wild plant foods would be sufficient to meet daily iron requirements for children and pregnant women, whereas over 100 g of cereal-based foods would be needed for the same purpose. These values emphasize the extraordinary nutrient density of wild plants and their potential to serve as iron-rich foods capable of addressing IDA in resource-limited communities (Abdellatef et al., 2025).

However, iron content alone does not determine nutritional efficacy; bioavailability is equally critical. Wild food plants such as *Balanites, Grewia, Moringa oleifera*, and okra are typically rich in vitamin C, organic acids, and carotenoids, which enhance iron absorption (Abdellatef et al., 2025). This natural combination of iron and absorption enhancers gives wild plants a biochemical advantage over phytate-rich cereals, where inhibitors dominate.

To improve conceptual clarity, it is important to distinguish between different levels of evidence when evaluating the nutritional potential of wild food plants. These include: (i) nutritional composition (e.g., total iron content), (ii) bioavailability (influenced by enhancers such as vitamin C and inhibitors such as phytates), (iii) dietary utilization (including traditional consumption patterns and food practices), and (iv) health outcome evidence (e.g., effects on haemoglobin levels or anaemia prevalence). While the present perspective highlights strong evidence for high iron content and favourable bioavailability characteristics in several wild species, evidence on actual dietary intake and clinical health outcomes remains comparatively limited and context-specific.

5. Empirical evidence of wild food plants enhancing micronutrient intake in Africa

Emerging evidence from observational and intervention studies indicates that wild and indigenous leafy vegetables can improve micronutrient intake and nutritional status in African populations.

Using high-resolution satellite imagery combined with Demographic and Health Survey data from over 15,000 households in West Africa, den Braber et al. (2024) found that even low levels of tree cover are associated with increased consumption of vitamin A–rich foods among young children. Conversely, a five-year study in rural Tanzania showed that deforestation led to an 11% decline in household fruit and vegetable consumption, with corresponding reductions in vitamin A adequacy (Hall et al., 2022). These findings suggest that forest-associated wild food plants contribute measurably to dietary quality.

Intervention studies have tested the efficacy of specific wild and semi-wild species. *Moringa oleifera* leaf powder, rich in iron and other micronutrients, has been evaluated in two settings. In Ghana, Moringa-fortified local dishes were well accepted by schoolchildren and showed significantly higher micronutrient content than non-fortified meals (Glover-Amengor et al., 2016). In Tanzania, six months of Moringa supplementation reduced anaemia prevalence by 53.6% in children under two years, compared to 13.6% in controls, with marked increases in haemoglobin levels (Shija et al., 2019). Similarly, a three-month intervention using dried green leafy vegetables in Ghanaian schoolchildren resulted in higher haemoglobin and serum retinol levels, and anaemia prevalence declined from 57.5% to 33.3% in the supplemented group (Egbi et al., 2018).

Among female small-scale farmers in rural Tanzania, consumption of dark green leafy vegetables (DGLVs), particularly when eaten with wholemeal millet, was strongly associated with improved iron and

Table 2
Comparative iron content of selected wild "iron-rich" food plants and common African staple cereals. The table presents total iron concentrations (mg/kg, dry weight basis) and the calculated dry weight amounts required to meet the Recommended Daily Allowance (RDA) for iron (7 mg/day for children, 27 mg/day for pregnant women).

Plant/ parts	Assay basis	Region	Iron content (mg/kg)	mg plant food meeting RDA *		References
				Children 7 mg/d	Pregnant Women 27 mg/d	
Balanites aegyptiaca / fruits	Dry weight	Ethiopia	452- 690	12	47	Mokria et al. (2022)
Grewia tenax / fruits	Dry weight	Sudan	200–220	33	128	Elhassan & Yagi (2010)
Parinari curatellifolia	Dry weight	Zimbabwi				Kaseke et al. (2025)
Pulps:			5000 – 8000	1	4	
Peels:			4038	1.7	6.6	
Seed:			3570	2	7.5	
Wheat/ grains	Dry weight	-	37–42	120	465	Zhou et al. (2024)
Maize/ grains	Dry weight	-	60	116	450	Kihara et al. (2024)
Sorghum/ grains	Dry weight	-	12–76	159	613	Ashok-Kumar et al. (2013)
Millet/ grains	Dry weight	-	30–140	82	317	Govindaraj et al. (2019)

*RDA: Recommended Daily Allowance.

vitamin A intake, as well as higher haemoglobin and serum retinol concentrations. Nevertheless, only a minority of women met recommended micronutrient intakes, underscoring both the potential and the limitations of DGLVs alone (Stuetz et al., 2019).

Observational evidence demonstrate that wild and indigenous leafy vegetables can improve iron and vitamin A status across diverse population groups. However, evidence directly linking wild fruit plant consumption to measurable health outcomes (e.g., changes in haemoglobin or anaemia prevalence) remains limited and represents a priority for future research.

Collectively, these studies provide evidence that biodiversity-associated foods, including wild and indigenous plant species, can improve dietary diversity, micronutrient intake, and nutritional status. While most available studies focus on leafy vegetables rather than wild fruits, the underlying mechanisms are relevant to both food groups. Forest and plants biodiversity supports the availability of nutrient-rich wild foods, traditional ecological knowledge facilitates their identification and utilization, and their consumption can enhance dietary diversity and the intake of iron and iron-absorption enhancers such as vitamin C and carotenoids. These processes may ultimately contribute to improved iron bioavailability, higher haemoglobin levels, and reduced risk of iron-deficiency anaemia.

To illustrate these relationships, Fig. 2 presents a conceptual framework linking forest biodiversity, indigenous wild food plants, dietary pathways, and reduced risk of iron-deficiency anaemia in conflict-affected settings. Despite the promising evidence, studies directly evaluating the effects of wild fruit consumption on haemoglobin concentrations and anaemia prevalence remain scarce and should be prioritized in future research.

6. Availability of the indigenous African-iron rich wild fruit plants

Indigenous African wild fruit plants such as *Parinari curatellifolia, Balanites aegyptiaca*, and *Grewia tenax* represent some of the most promising natural resources for improving iron nutrition across pan Africa (Abdellatef et al., 2025). These species are widely distributed across various ecological zones of Africa and have long been integrated into traditional food systems. Their natural resilience to harsh environmental conditions, coupled with their high nutritional value especially in terms of iron content makes them valuable yet underutilized components of African agroecosystems. *Parinari curatellifolia*, commonly known as the Mobola plum, is found predominantly in sub-Saharan Africa, with extensive presence in Southern, Central, and parts of West and East Africa (Fig. 2). It thrives in woodlands, savannas, and semi-arid zones, often on sandy or loamy soils. The species is remarkably drought-tolerant and capable of producing fruit even under marginal rainfall conditions. The wide distribution of *Parinari curatellifolia* across regions such as Zimbabwe, Zambia, Malawi, Tanzania, and Mozambique highlight its potential as a regionally available "iron-rich" food that could be leveraged to combat iron-deficiency anaemia where dietary diversity is low (Kaseke et al., 2025). *Balanites aegyptiaca*, also known as the desert date, is one of the most ecologically versatile indigenous species in Africa. Its distribution spans North, West, East, and parts of Southern Africa, extending into arid and semi-arid regions such as the Sahel, Sudanian, and Horn of Africa zones (Fig. 3). The tree thrives under extreme conditions tolerating prolonged drought, high salinity, and degraded soils making it particularly valuable for dryland reforestation and nutrition initiatives. Beyond its nutritional importance, *Balanites aegyptiaca* provides multiple ecosystem services, including fuelwood, fodder, and medicinal compounds. The fruits, seeds, and leaves are locally consumed, often in processed or dried forms, and serve as critical food sources during the dry season when other crops are scarce. Its abundance in regions most affected by malnutrition underscores its strategic importance for food security and nutritional resilience (Mokria et al., 2022). *Grewia tenax*, locally known as "Godeim" or "Tseeda," is another widely available wild fruit species native to semi-arid and savanna ecosystems across Africa. It is particularly common in Sudan, Ethiopia, Kenya, Tanzania, Chad, Nigeria, and parts of Southern Africa (Fig. 3). The shrub is well adapted to poor soils and low rainfall environments, producing small orange to yellow fruits rich in iron and other micronutrients. In many rural communities, *Grewia tenax* fruits are consumed fresh or processed into beverages, jams, or dried snacks. Its availability during the dry season provides an important dietary bridge when agricultural food supplies are limited. The plant's wide geographic spread and adaptability make it a practical target for community-based nutrition interventions, especially in pastoral and semi-nomadic populations (Elhassan & Yagi (2010). Overall, the distribution patterns of these three indigenous wild fruit plants illustrated in the accompanying map demonstrate their broad ecological coverage and accessibility across Africa. They occupy regions where iron-deficiency anaemia prevalence is among the highest, suggesting that promoting their consumption could have substantial public health benefits. Integrating these wild species into local diets, food value chains, and agroforestry systems offers a sustainable strategy to enhance iron intake, diversify food sources, and strengthen nutrition security in both rural and peri-urban settings. Efforts to domesticate and integrate these species into agroforestry and farming systems are increasingly reported. Balanites aegyptiaca has been actively promoted in dryland agroforestry systems due to its drought tolerance and multiple uses, including food, fodder, and medicinal applications (Chérif et al., 2023). Grewia tenax has been subject to propagation and nursery trials aimed at improving fruit yield and accessibility in Sudan, with studies highlighting its potential for cultivation in marginal lands (Musa et al., 2025). Similarly, Parinari curatellifolia has attracted attention for domestication due to its high nutritional value and adaptability, although cultivation remains limited and requires further research on germination, growth performance, and yield optimization (Kaseke et al.,

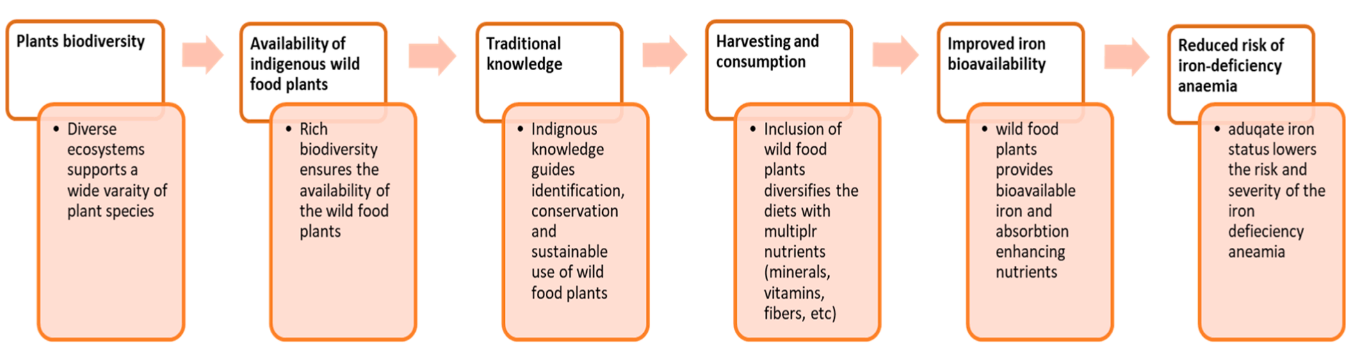

Fig. 2. Conceptual pathway linking forest biodiversity to reduced risk of iron-deficiency anaemia. Forest biodiversity supports the availability of indigenous wild food plants, which, through traditional ecological knowledge and consumption practices, contribute to dietary diversity, improved iron intake and bioavailability, higher haemoglobin levels, and ultimately reduced risk of iron-deficiency anaemia.

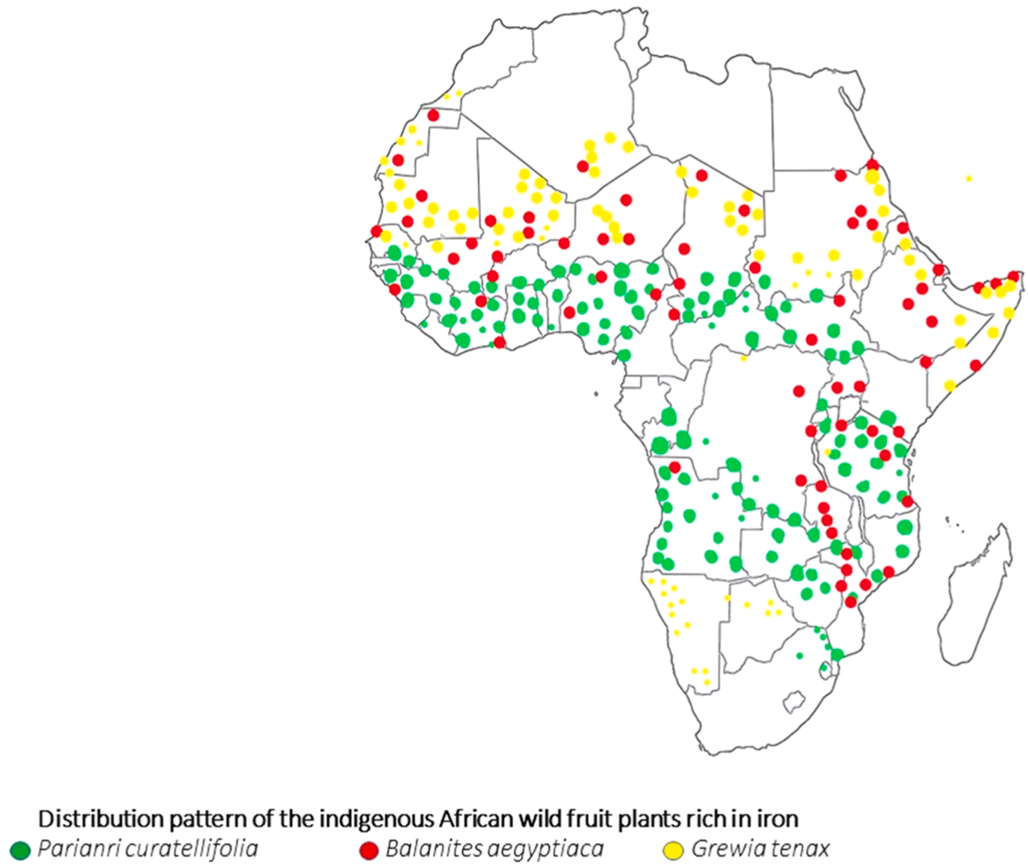

Fig. 3. Geographical distribution of selected indigenous African wild fruit plants rich in iron. The map illustrates the occurrence and distribution patterns of three highly iron-rich wild fruit species across the African continent: Parinari curatellifolia (green dots), Balanites aegyptiaca (red dots), and Grewia tenax (yellow dots). These species are widely distributed across arid and semi-arid regions, particularly in West, East, and Southern Africa. Their broad ecological adaptation highlights their potential as regionally available, nutrient-dense resources for combating iron-deficiency anaemia and improving dietary diversity in local food systems. "The map should be interpreted as a qualitative overview rather than a quantitative or spatially precise representation".
Source: https://africanplantdatabase.ch/en

2025). These initial efforts demonstrate the feasibility of transitioning from wild collection to semi-cultivated or cultivated systems, though more coordinated research and investment are needed. Continued efforts in domestication, processing, and value addition could further improve their year-round availability and cultural acceptance, transforming them from overlooked wild foods into mainstream nutritional assets across Africa.

7. Conclusion

Iron-deficiency anaemia remains a pervasive and life-threatening condition among internally displaced persons (IDPs) in sub-Saharan Africa. In conflict settings characterized by displacement and chronic food insecurity, reliance on imported or fortified foods is often neither practical nor sustainable. This perspective has examined the potential role of indigenous African wild food plants, specifically *Parinari curatellifolia, Balanites aegyptiaca*, and *Grewia tenax*, as accessible, nutrient-dense, and ecologically resilient sources of dietary iron.

The available evidence supports several key observations. These species thrive in harsh environments where staple crops frequently fail, providing seasonally available food resources for vulnerable communities. Their high iron content, together with natural cofactors such as vitamin C and carotenoids that enhance iron absorption, positions them as nutritionally valuable foods with potential to contribute to alleviating iron-deficiency anaemia among IDPs and other at-risk populations. However, several constraints must be acknowledged.

Biologically, iron bioavailability from wild plant foods can be influenced by residual anti-nutritional factors (e.g., tannins, phytates) depending on preparation methods, and individual variation in iron absorption efficiency may affect nutritional outcomes. Socio-economically, barriers include seasonal and geographical variability in wild plant availability, erosion of traditional ethnobotanical knowledge across generations, land degradation and deforestation, limited integration into formal food assistance programs, and inadequate infrastructure for harvesting, processing, and storage. Furthermore, displacement itself may separate IDPs from familiar environments where they would recognize and safely harvest these plants.

These constraints do not invalidate the potential of wild food plants but rather define the conditions under which they can be effectively utilized. Integrating these species into local food systems, humanitarian nutrition strategies, and agroforestry initiatives could improve dietary diversity, micronutrient intake, and community resilience. Beyond nutritional benefits, these species may contribute to ecosystem restoration, carbon sequestration, and livelihood diversification, aligning with principles of sustainable and climate-smart food systems.

Realizing this potential will require interdisciplinary collaboration to advance domestication, ensure food safety, enhance value addition, promote culturally appropriate consumption, and generate rigorous impact evaluations measuring clinical outcomes such as haemoglobin concentrations. In summary, indigenous African wild food plants represent a promising nature-based complement to existing nutrition interventions in conflict settings, but they are not a standalone solution. Evidence for their nutritional composition is strong, while evidence for direct health impacts remains preliminary. Addressing biological and socio-economic barriers will be essential to translate nutritional potential into measurable public health benefits.

Policy recommendations

- Promote awareness and training on identification, harvesting, and preparation of iron-rich wild food plants among IDPs through locally adapted educational materials.
- Support research and domestication programs to improve cultivation, yield, and year-round availability of key wild species.
- Facilitate seed and seedling distribution systems to enable integration of these species into household and community agroforestry systems.
- Integrate wild food plants into humanitarian nutrition strategies, including food assistance and dietary diversification programs.
- Strengthen multi-stakeholder collaboration among research institutions, humanitarian organizations, and national authorities to develop context-specific implementation strategies.
- Document and preserve indigenous knowledge systems related to wild food plants to ensure sustainable use and intergenerational knowledge transfer.
- Promote value addition and processing techniques that enhance iron bioavailability and cultural acceptability.

Consent for publication

Not applicable.

Consent to participate

Not applicable.

Ethics declaration

not applicable.

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CRediT authorship contribution statement

Eltayb Abdellatef: Conceptualization, Data curation, Formal analysis, Validation, Visualization, Writing – original draft, Writing – review & editing. **Yohannes Gedamu:** Validation, Writing – review & editing. **Petra Bauer:** Conceptualization, Funding acquisition, Project administration, Supervision, Validation, Visualization, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

No data was used for the research described in the article.

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